U.S. Department of Energy

Radionuclide Air Emissions Annual Report

Calendar Year 2001

Rocky Flats Environmental Technology Site

U.S. Department of Energy

Radionuclide Air Emissions Annual Report for Calendar Year 2001

Prepared in accordance with
40 CFR 61, Subpart H
and
CAQCC Regulation No. 8, Part A, Subpart H

Site Name: Rocky Flats Environmental Technology Site

Operations Office Information

Office: Rocky Flats Field Office
Address: U.S. Department of Energy
Rocky Flats Environmental Technology Site
10808 Hwy 93, Unit A
Golden, Colorado 80403-8200
Contact: Jonathan Dion Phone: (303) 966-5904

Site Information

Site Operator: Kaiser-Hill Company, L.L.C.
Address: Rocky Flats Environmental Technology Site
10808 Hwy 93, Unit B
Golden, Colorado 80403-8200
Contact: Andrew Rosenman Phone: (303) 966-3687

Executive Summary

As required by Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H, and Colorado Air Quality Control Commission Regulation No. 8, Part A, Subpart H, the airborne radiation dose to the public from the Rocky Flats Environmental Technology Site (Site) is determined annually and reported to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE). These regulations limit the air pathway dose from Site activities to any member of the public to an annual effective dose equivalent (EDE) of 10 millirem (mrem). The Site was in compliance with the 10-mrem standard during 2001.

To provide context for the 10-mrem annual standard limitation, the average annual EDE for residents of the Denver area from **all** sources of radiation is approximately 420 mrem. Over 80% of this average annual EDE is due to natural background radiation (Roberts, 1998). The health risk associated with 1 mrem of EDE from naturally occurring sources of background radiation (such as uranium or thorium in rock or soil, cosmic rays, and radon emitted from soil or bedrock) is the same as that produced from anthropogenic sources of radiation (such as Site activities or medical x-rays).

Compliance with the 10-mrem standard was determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when each measured radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2001, each measured radionuclide air concentration was less than 1% of the corresponding concentration level for environmental compliance and the fractional sum of all radionuclides was less than 1.5% of the allowable level at the sampler with the highest fractional sum (the critical receptor).

Airborne radionuclides appear to have been dominated by naturally occurring uranium isotopes in 2001. For example, at the critical receptor, uranium isotopes characteristic of naturally occurring uranium contributed approximately 95% of the fractional sum. In addition, the location where the highest total radionuclide levels were measured in 2001 (northwest of the Site) was influenced by off-Site activities that generated dust, such as traffic, sand and gravel removal operations, or quarrying operations. These patterns are consistent with sampling results from 1997, 1998, 1999, and 2000.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

Am	Americium
Ave	Avenue
Bq	Becquerel(s)
CAP88-PC	Clean Air Act Assessment Package-1988
CAQCC	Colorado Air Quality Control Commission
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curies
Ci/yr	Curies per year
cm	Centimeter(s)
cm^2	Square centimeters
CY	Calendar Year
DOE	U.S. Department Of Energy
dpm	Disintigrations per minute
DRCOG	Denver Regional Council of Governments
EDE	Effective dose equivalent
EIS	Effluent Information System
EPA	U.S. Environmental Protection Agency
ft	Feet
HEPA	High efficiency particulate air (filter)
ID	Identifier
in	Inch
kg	Kilogram
km	Kilometer(s)
km^2	Square kilometer(s)
m	Meter(s)
m^2	Square meters
m^3	Cubic meters(s)
mrem	Millirem
m/s	Meters per second
mSv	MilliSievert(s)
NW	Northwest
ODIS	Off-Site Discharge Information System
pCi/g	Picocuries per gram
Pu	Plutonium
RAAMP	Radioactive Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
Rd	Road
rem	Roentgen equivalent man
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office

ABBREVIATIONS AND ACRONYMS (continued)

SE	Southeast
Site	Rocky Flats Environmental Technology Site
SNM	Special nuclear material
St	Street
Sv	Sievert(s)
TRU	Transuranic
U	Uranium
USC	United States Code
UTM	Universal Transverse Mercator
WIPP	Waste Isolation Pilot Plant
yd^3	Cubic yards
°C	Degrees Celsius
µCi	Microcuries

1.0 INTRODUCTION

The Rocky Flats Environmental Technology Site (RFETS or Site) is subject to *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Title 40 of the Code of Federal Regulations [CFR], Part 61, Subpart H). Regulation 40 CFR 61, Subpart H, applies to operations at any facility owned or operated by the U.S. Department of Energy (DOE) that emits radionuclides (other than radon-222 and radon-220) into the air. The standard requires that emissions of radionuclides to the ambient air from the Site not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 millirem (mrem) (0.1 milliSieverts [mSv]). Colorado has incorporated 40 CFR 61, Subpart H, by reference as Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart H.

Regulation 40 CFR 61, Subpart H, Section 61.94, requires the Site to demonstrate compliance with the standard for the previous calendar year and to submit this information, along with other data, to the U.S. Environmental Protection Agency (EPA) in an annual report (CAQCC Regulation No. 8, Part A, Subpart H, requires submittal to the Colorado Department of Public Health and Environment [CDPHE]). This report fulfills the reporting requirements of 40 CFR 61.94 and CAQCC Regulation No. 8, Part A, Section 61.94, for the 2001 calendar year.

In 1997, DOE filed an application with EPA and CDPHE requesting approval of an alternative compliance demonstration method for 40 CFR 61, Subpart H (DOE, 1997). The alternative method is based on environmental measurements of radionuclide air concentrations at critical receptor locations, rather than the dispersion modeling approach outlined in the regulation itself. In cases where nonpoint sources of emissions are the primary contributors to dose, as has been the case at the Site since before 1995, such an alternative method based on environmental measurements is recommended by EPA (EPA, 1991).

The alternative compliance demonstration method has been approved by CDPHE and EPA. The compliance sampling network, which consists of 14 samplers located around the perimeter of the Site, became fully operational in 1999. The samplers are part of the Site's Radioactive Ambient Air Monitoring Program (RAAMP) network. Compliance has been determined using the alternative method for this annual report.

2.0 FACILITY INFORMATION

This section describes the Rocky Flats Environmental Technology Site, lists the radioactive materials used at the Site, and describes the handling and processing that the radioactive materials undergo. New construction or modifications in calendar year 2001 for which construction approval and startup notification were waived per 40 CFR 61.96 are also identified in this section. Construction approval and startup notification were not required for any new construction or modification in 2001.

2.1 Site Description

The Rocky Flats Environmental Technology Site is operated by Kaiser-Hill Company, L.L.C., with oversight by the Rocky Flats Field Office (RFFO) of the U.S. Department of Energy. Prior to 1989, the Site fabricated nuclear weapons components from plutonium, uranium, beryllium, and stainless steel. Production activities included metal fabrication and assembly, chemical recovery and purification of process-produced transuranic (TRU) radionuclides, and related quality control functions. Plutonium weapons operations were curtailed at the Site in 1989 due to safety concerns, and in February 1992, the Site's weapons production mission was discontinued. The Site is now undergoing decommissioning and cleanup, and is moving toward final closure.

The Site occupies an area of 26.5 square kilometers (km^2) in northern Jefferson County, Colorado, about 25.7 kilometers (km) northwest of Denver. The Site is located at approximately 1,829 meters (m) above mean sea level on the eastern edge of a geological bench known locally as Rocky Flats. This bench, about 8.1 km wide in an east-west direction, flanks the eastern edge of the Rocky Mountains.

Over 2.9 million people live within 80 km of the Site. Adjacent land use is a mixture of agriculture, open space, industry, and residential housing. Surrounding communities include the city of Golden to the south of the Site; the cities of Arvada, Broomfield, and Westminster to the east; and the city of Boulder to the north. An area map is shown in Figure 2-1.

The former production facilities are located near the center of the Site. The remaining Site area contains support facilities and serves as a buffer zone for former production facilities. A map of the Site is shown in Figure 2-2; a simplified map of the central portion of the Site (the "industrial area") showing the location of the former production facilities can be seen in Figure 2-3.

The central portion of the Site, which houses the former production facilities, can be roughly divided into halves. The northern half of the central area historically housed plutonium processing operations and, until recently, was surrounded by a security perimeter (the Original Protected Area shown in Figure 2-3). During 2001, the area

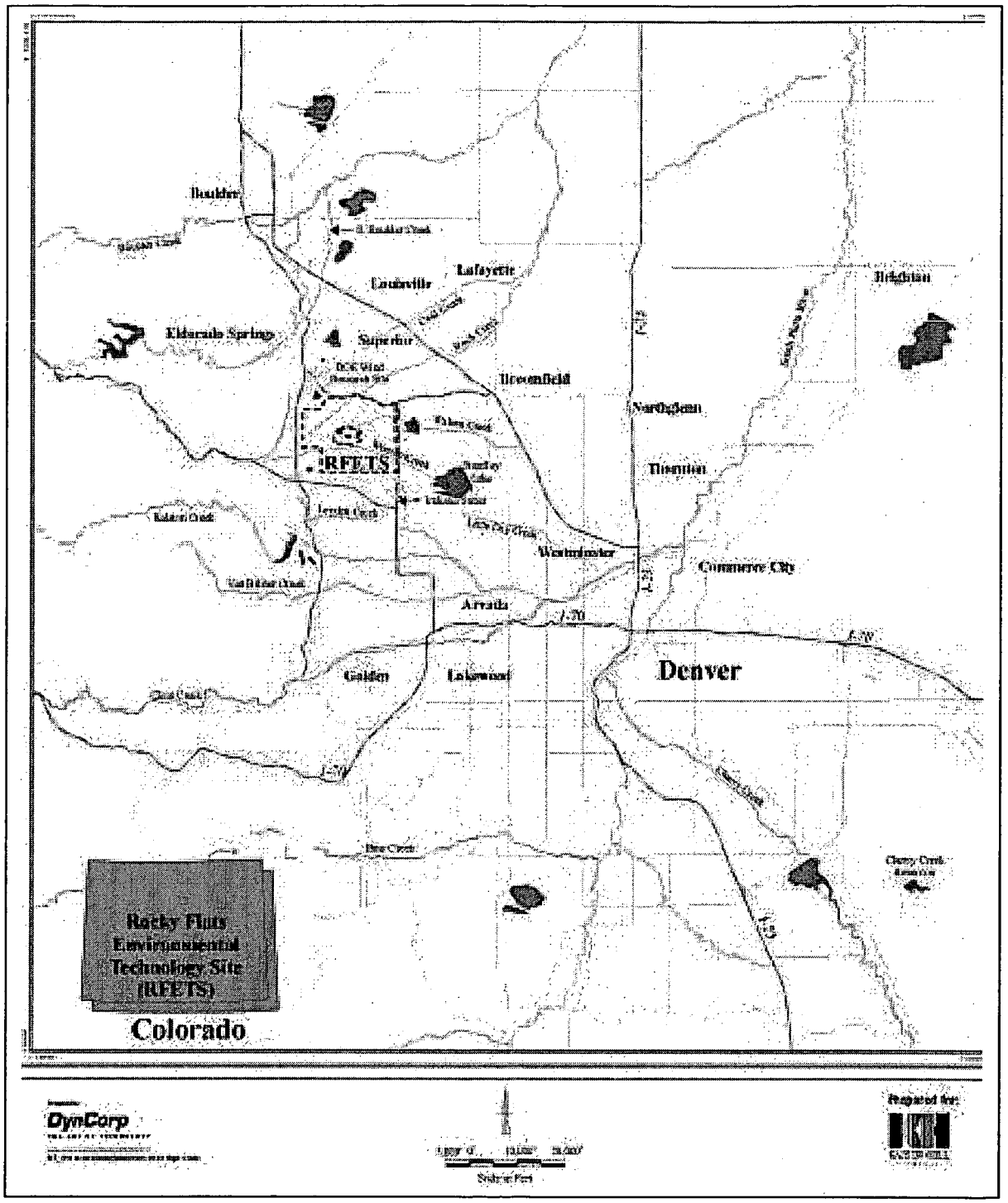


Figure 2-1. Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities

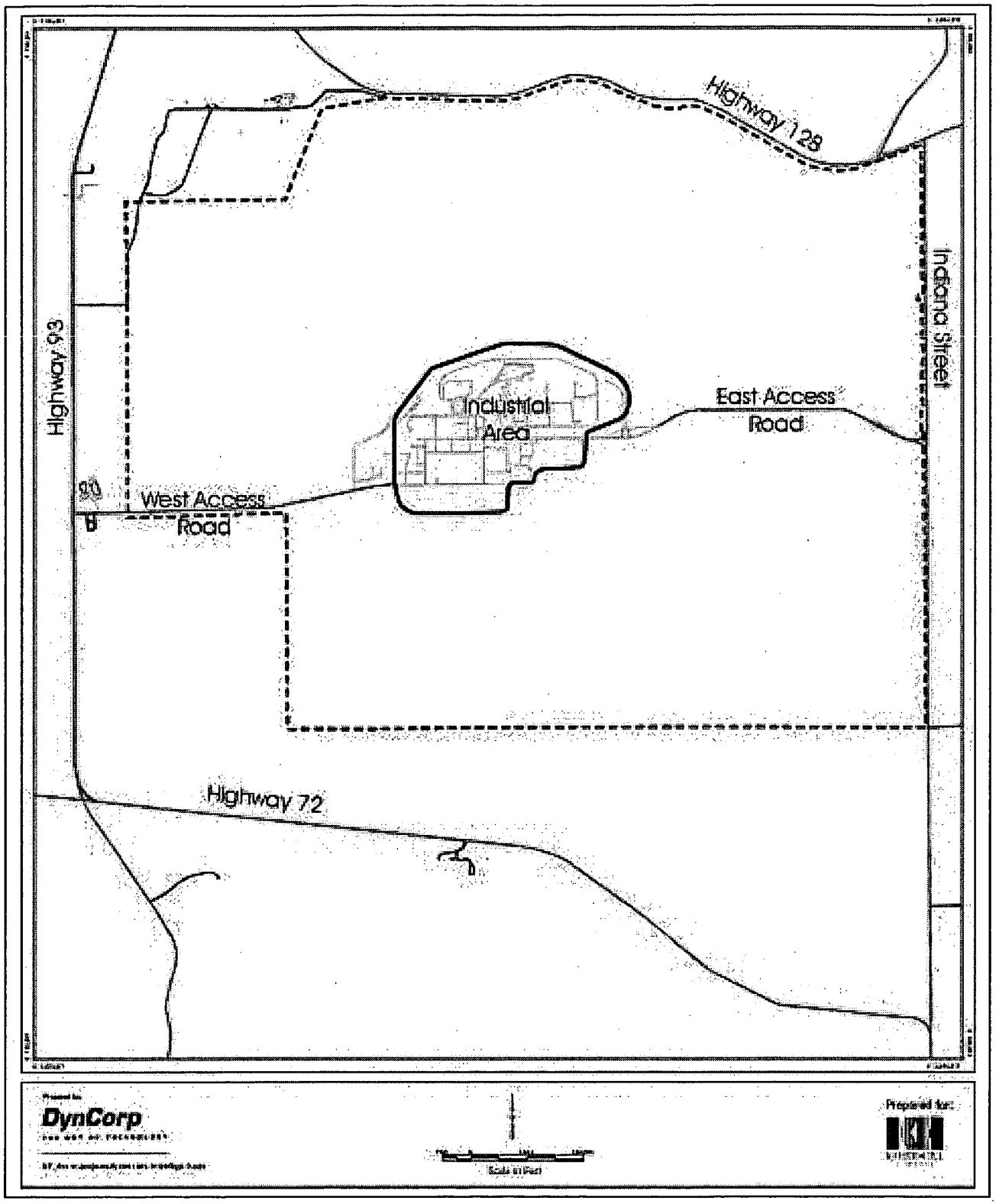


Figure 2-2. Rocky Flats Environmental Technology Site Location Map

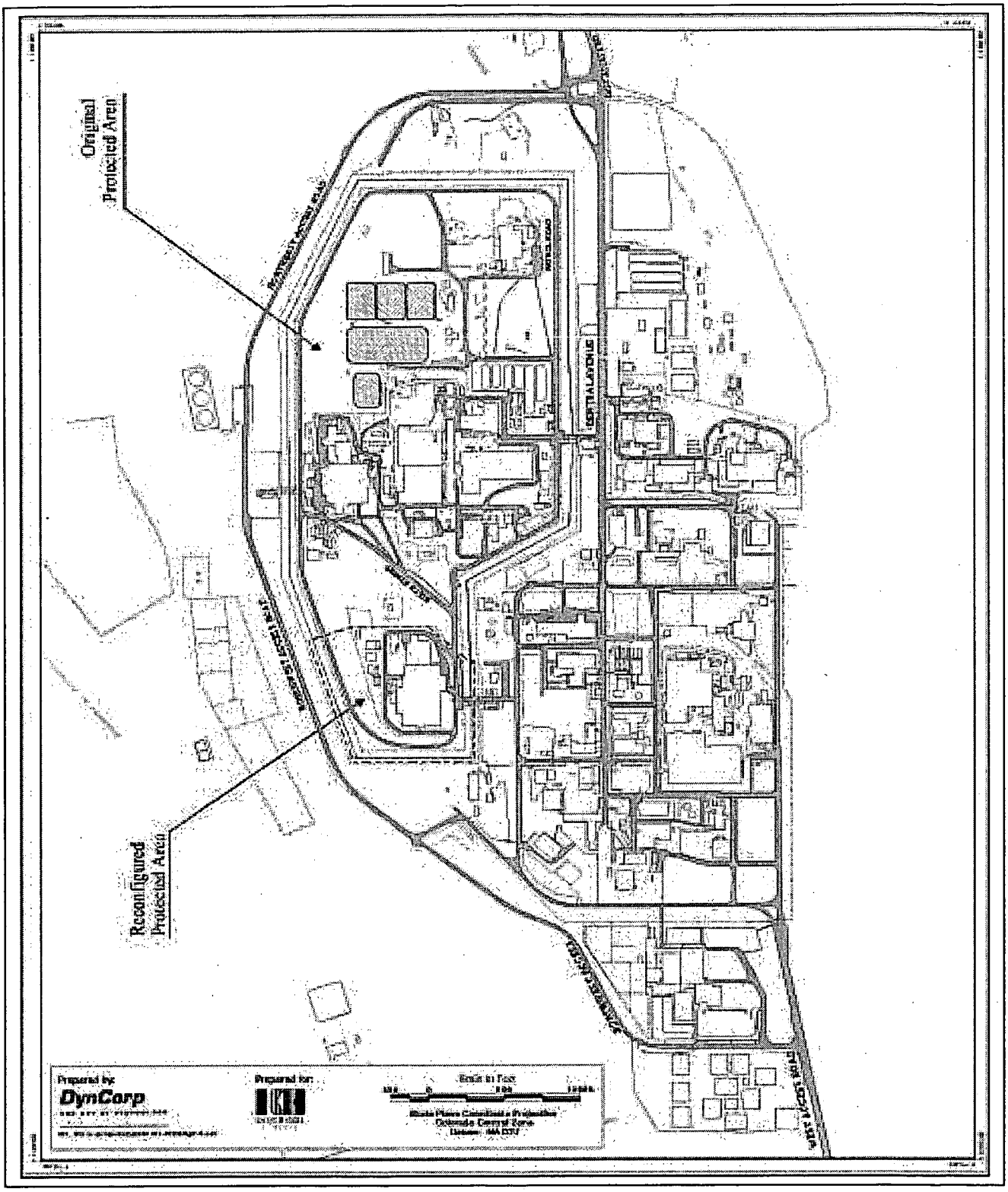


Figure 2-3. Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area)

surrounded by the security perimeter was reduced in size (the Reconfigured Protected Area shown in Figure 2-3). The rest of the industrial area (south side) housed uranium, beryllium, and stainless steel operations.

2.2 Radionuclide Air Emissions Source Description

Radioactive material handling at the Site is currently focused on material consolidation, environmental restoration, building decommissioning, radioactive residue repackaging, waste processing, and analytical operations. Most of the radionuclide air emissions from the Site result from nonpoint (diffuse) sources, primarily mechanical and natural disturbances of contaminated soil. Soil contamination was caused by past radioactive material spills and other releases. In addition, the soils on and around the Site contain small quantities of naturally occurring radionuclides.

Radioactive material processing can result in radionuclides becoming entrained in ventilation air (effluent) that is released through vents or stacks (point sources). However, because no routine nuclear weapons-related processing has occurred at the Site since 1989, most radionuclide point source emissions result from the resuspension of residual radioactive material in ventilation systems and from decontamination and deactivation activities taking place in process buildings.

Air exhausted from process buildings is cleaned prior to release by passing it through multiple stages of high efficiency particulate air (HEPA) filters. As a result, radionuclide point source emissions from the Site are very low.

2.2.1 Radioactive Materials Handling and Processing in Calendar Year 2001

In 2001, radionuclide emissions from the Site occurred from several activities that either disturbed resident contamination in buildings or in soil, or that processed or used radionuclide-containing substances such that emissions to the atmosphere resulted. Appendix A lists radioactive materials associated with the Site. The list of radionuclides includes plutonium (Pu)-239/240, americium (Am)-241, uranium (U)-233/234, U-235, and U-238. The Site also has small quantities of beta- and gamma-emitting sealed sources and low activity analytical stock solutions, powders, and plated sources; emissions from these sources were negligible.

The major Site activities and sources that handled or processed radionuclides in calendar year 2001, with resulting radionuclide emissions, are described below.

Hold-up in Ducts

Radionuclide emissions were generated through disturbance of radionuclide-contaminated dust and other deposits on the surfaces of ventilation ducts exiting process

areas. These materials were deposited on duct walls and in rapidly decreasing amounts on successive stages of HEPA filters during many years of weapons component production. Routine air movement and pressure changes in the ducts entrain a small amount of this contamination on an ongoing basis. In addition, decontamination and equipment removal or reconfiguration activities disturbed a portion of the hold-up in certain ducts in 2001, resulting in additional emissions to the atmosphere. Ducts containing hold-up were vented through multiple stages of HEPA filters.

Resident Contamination

In some process areas, contamination may be found on glovebox surfaces and floors, and, in limited cases, in the rooms themselves. This contamination has been surveyed and estimated using surface swipes in the areas. As with hold-up, resident contamination was emitted in 2001 due to routine exposure to ventilation air and due to active disturbance by project activities, particularly decontamination and equipment movement. Ducts venting areas with significant contamination were exhausted through multiple stages of HEPA filters.

Consolidation of Special Nuclear Material (SNM)

SNM is plutonium and enriched uranium contained in weapons components, metals, metal alloys, and oxides. SNM-related consolidation activities continued in calendar year 2001 and included metal brushing, size reduction of metal, thermal stabilization of oxide, and packaging and interim storage of SNM. These consolidation activities are defined as follows:

- Metal brushing: Mechanical removal of metal oxide from metal surfaces.
- Size reduction: Reduction of material size by breaking, cutting, sawing, or pressing to accommodate storage container requirements.
- Thermal stabilization of oxide: Treatment of unstable forms of metal oxides in furnaces operating in the range of 800 to 1,200 degrees Celsius (°C) to remove moisture and to fully oxidize the metal to stable form.
- Packaging and storage: Placement of material in approved, inert atmosphere, storage containers, which in turn are placed in storage vaults or vault-type rooms. Storage vaults are repositories of SNM materials that satisfy required safety and risk criteria.

Consolidation activities resulted in radionuclide emissions in 2001 through exposure of SNM to ventilation air, as well as through mechanical and thermal disturbance of SNM.

Consolidation was performed in areas where ventilation air was exhausted through HEPA filters.

Waste Handling

Most of the low-level and TRU waste materials at the Site were generated during plutonium weapons component production and radionuclide recovery operations conducted prior to 1989. In 2001, solid waste, including contaminated gloveboxes and duct work, was segregated and size-reduced prior to packaging for storage and disposal. Such activities disturbed the radioactive contamination in the waste, resulting in radioactive particles in the room air.

Radioactive wastes were handled (segregated, size-reduced, and packaged) inside buildings or other structures. Venting the air through HEPA filters controlled emissions from these operations.

In addition to solid waste, liquid waste in tanks and pipes may also release radionuclides to the atmosphere, either through routine passive venting, or when liquid waste is exposed to the atmosphere when systems are drained or the materials treated. In addition to routine emissions from tank vents, liquid radioactive waste movement projects in several buildings contributed to emissions during 2001. These activities took place in areas that vented through HEPA filters.

Waste Storage

Packaged low-level and TRU wastes are commonly stored in drums at various locations on the Site. Drums are vented to prevent pressure buildup from hydrogen gas, which is generated by radiolytic activity affecting packaged materials. Radionuclide emissions would only occur from these drums during venting if the inner packaging failed. To minimize emissions should the inner packaging fail, the drums were equipped with small filter cartridges that functioned like HEPA filters. For purposes of estimating emission potential for compliance with 40 CFR 61, Subpart H, the packaged materials inside these drums were considered sealed sources (in accordance with Appendix D to 40 CFR 61).

Waste Repackaging

Radionuclide emissions were generated in 2001 from waste characterization and repackaging activities that support waste shipment activities. Shipment plans required the characterization and repackaging of various radionuclide-contaminated wastes and residues in preparation for shipment to the Nevada Test Site, Savannah River Site, the Waste Isolation Pilot Plant (WIPP), or other off-Site facilities. All of the waste repackaging activities that occurred in 2001 took place in areas that were vented through HEPA filters.

Building/Structure Demolition Projects

Demolition projects at the Site are performed in accordance with the Rocky Flats Cleanup Agreement (RFCA). RFCA is a negotiated, interagency agreement governing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup activities at the Site. RFCA states that all unneeded buildings at the Site will be demolished. In most cases, contaminated systems are decontaminated and removed prior to demolition.

In 2001, the following structures were demolished: Buildings 111, 333, 762, 762A, 792, 792A, and 888; Guard Towers 550, 761, and 901; Cooling Towers 709, 560, 712, 373, and 713; and Trailers 883A, 883B, 551A, 891B, and 331A. These structures were not radiologically contaminated.

Miscellaneous Point Sources

In late 1997, several laboratory operations were transferred to a new modular laboratory. The modular analytical laboratory continued operations in 2001. Radionuclide emissions from the handling of contaminated media (such as filters) were negligible.

Other miscellaneous point sources that were initiated or modified in 2001 included revisions to an ongoing drum crushing activity at the 750 Pad, Tent 5; new laboratory operations in Building 559 (ceramification of plutonium-containing waste); renewed operation of the spray dryer in Building 374; and repackaging of ash and dry residues in Building 371. These operations are described in more detail in Section 2.2.2.

Miscellaneous Nonpoint Sources

Another contributor to Site radionuclide emissions in 2001 was the resuspension of contaminated soils. Contaminated soils were resuspended by wind erosion, vehicle traffic, and other mechanical soil disturbances. Miscellaneous nonpoint sources that emitted radionuclides in 2001 included asphalt replacement at the 750 Pad (Tent 5), installation of fork truck paths and concrete trailer pads, and installation of surface water monitoring stations (these sources are described in more detail in Section 2.2.2). Emissions generated by wind erosion were uncontrolled, while radionuclide emissions from vehicle traffic and mechanical disturbances were sometimes controlled using dust suppression techniques.

2.2.2 New Construction and Modifications in Calendar Year 2001

Seven new or modified activities that contributed to the Site air pathway dose in calendar year 2001 are described below. As part of the project evaluation process (prior to the startup of each project), the maximum annual (controlled) off-Site EDE that could result

from each new or modified activity was calculated to determine approval and notification requirements. Maximum potential radionuclide emissions were estimated using emission and control factors from Appendix D to 40 CFR 61, combined with information regarding radionuclide contaminant levels and material forms, radionuclide release mechanisms, and the radionuclide emission controls employed. In cases where HEPA filters were employed, credit was taken for a maximum of two stages, although up to four stages may actually have been employed. Emissions were modeled using the Clean Air Act Assessment Package-1988 (CAP88-PC), and recent Site meteorological data to estimate annual EDEs at the most impacted off-Site residence and business locations.

To place the reported EDE values in context, it should be noted that the emission estimation and modeling methods used in this exercise are designed to generate "worst case" dose estimates. The emission factors, control device efficiencies, and modeling approach are mandated by 40 CFR 61, Appendix D, to ensure that project dose will not be underestimated when determining whether notification and approval are necessary under the regulation. In fact, actual emissions and dose will often be much lower than the estimates used to determine approval and notification requirements.

Detailed data and calculations used to develop emission estimates and resulting dose projections are maintained in Site files. The estimated EDE (shown below) for each new construction or modification was less than 1% of the 10-mrem (0.1-mSv) standard, and construction approval and startup notification were unnecessary under 40 CFR 61.96. The EDEs used in making regulatory applicability decisions regarding approval requirements are discussed below.

750 Pad, Tent 5 Drum Crusher: In 2000, a drum crusher was installed and operated within the Tent 5 containment structure at the 750 Pad. Operation of the drum crusher was initially limited to empty drums with contamination levels less than or equal to 20 disintegrations per minute (dpm) per 100 square centimeters (cm^2). The maximum process rate of the drum crusher was approximately 30 drums per hour. In 2001, the maximum contamination level of the drums was raised to 100,000 dpm/100 cm^2.

The permacon air exhausted through a single-stage HEPA filter. For 2001, dose calculations were based on the conservative assumptions that the crusher would operate at the maximum process rate 24 hours per day, 5 days per week, 52 weeks per year and that each drum was contaminated at 100,000 dpm/100 cm^2 over the entire surface area. Using emission factors from 40 CFR 61, Appendix D, the maximum annual (controlled) off-Site EDE for this project was estimated to be 1.2×10^{-6} mrem (1.2×10^{-8} mSv).

Building 371 Ash and Dry Residues Processing: In 2001, ash and dry residues were processed in Building 371. Residues underwent visual examination, and were repackaged to meet WIPP waste acceptance criteria requirements. The process operated one shift per day, 5 days per week.

The process air exhausted through four stages of HEPA filters, and through a vent that was continuously sampled for radionuclide emissions. The off-Site EDE was calculated based on the average plutonium content of the residues, the process rate, and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 6.3×10^{-5} mrem (6.3×10^{-7} mSv).

Building 374 Spray Dryer Operation: The spray dryer in Building 374 was revitalized in 2001 to treat the backlog of liquid radioactive concentrate stored at the Site. Concentrated liquid was fed into the spray dryer chamber where it was dried into salt, which was filtered and loaded into drums for shipment. For 2001, dose calculations were based on the conservative assumptions that the spray dryer operated at the maximum design rate 24 hours per day, 5 days per week, 52 weeks per year.

The process air exhausted through two stages of HEPA filters. The off-Site EDE was calculated based on the maximum radionuclide content of the influent; the maximum design process rate operating 24 hours per day, 5 days per week, 52 weeks per year; and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 6.0×10^{-7} mrem (6.0×10^{-9} mSv).

Building 559 Plutonium Fluoride Residue Blend Material Testing: In 2001, laboratory treatability studies were performed to develop a blend material for encapsulating various plutonium-containing solid and liquid wastes. Testing was done on a maximum of 200 samples containing no more than 50 grams (g) of plutonium per sample. The testing process operated for a maximum of one shift per day, five shifts per week, for 35 weeks.

Testing took place in a glovebox that exhausted through four stages of HEPA filters, and through a vent that was continuously sampled for radionuclide emissions. The off-Site EDE was calculated based on the maximum plutonium content in each sample, the maximum process rate, and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 1.7×10^{-6} mrem (1.7×10^{-8} mSv).

750 Pad Asphalt Repair: A damaged asphalt area to the east of Tent 5 at the 750 Pad was excavated and removed in 2001, and replaced with a concrete access way. Sub-grade soils were scarified and removed to a depth of 15 to 30 cm. The total volume of soil disturbed or excavated during this project did not exceed 31 cubic meters (m^3), and radionuclide contamination levels in the soil did not exceed RFCA Tier II soil action levels. RFCA defines Tier I and Tier II soil action levels based on concentrations of various contaminants in the soil, where contamination above the higher Tier I action levels suggests cleanup may be necessary, while contamination above Tier II represents contaminant concentrations that require further evaluation. Contamination below Tier II soil action levels does not require further action.

Dose calculations from excavation and backfilling activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II soil action levels), the volume of soil excavated and backfilled, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 3.9×10^{-6} mrem (3.9×10^{-8} mSv).

Installation of Fork Truck Paths and Trailer Pads at Building 664: In 2001, two fork truck paths and two concrete trailer pads were constructed immediately south of Building 664. The total volume of soil disturbed or excavated during this project did not exceed 497 m^3, and radionuclide contamination levels in the soil did not exceed RFCA Tier II soil action levels.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and estimated conservative isotopic contamination levels in the soil (Tier II soil action levels). The maximum annual off-Site EDE from the project was estimated to be 1.0×10^{-3} mrem (1.0×10^{-5} mSv).

Installation of Surface Water Monitoring Stations: In 2001, the Site Water Programs installed four surface water monitoring stations southeast of the 903 Pad, near the South Interceptor Ditch. The monitoring stations were installed as RFCA performance monitoring locations to provide project-specific monitoring prior to, during, and after the 903 Pad remediation project.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and estimated conservative isotopic contamination levels in the soil (Tier II soil action levels). The maximum annual off-Site EDE from the project was estimated to be 5.0×10^{-4} mrem (5.0×10^{-6} mSv).

3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 2001. The stacks, vents, and other points where radioactive materials were released to the atmosphere are described, and the effluent controls employed by the Site to minimize emissions are discussed.

3.1 Emission Determination Process

The emission data presented in this section represent an estimate of Site radionuclide air emissions in calendar year 2001. In many cases, air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured. Where such data were available, they are presented here. In other cases, emissions from activities that generated airborne radionuclides were not measured. For these activities, emissions were estimated based on information regarding the specific project or process, combined with emission factors from various sources. Emission sources that were clearly negligible were not quantified.

Where emissions reported in this section were estimated, rather than directly measured, the emission estimates were based on:

- The radionuclide content of materials handled or processed;
- The form of the radioactive material (gas, liquid, solid, or particulate);
- The mechanisms by which radionuclides were released to the atmosphere;
- The time over which the activities that released radionuclides occurred or the time that the radioactive material was exposed to the atmosphere;
- The control measures employed to reduce radionuclide emissions (a maximum of two stages of HEPA filters were credited, even if additional stages were actually employed); and
- Emission factors appropriate to a given process or activity.

Emission factors were derived from several sources. Radionuclide emission factors listed in Appendix D to 40 CFR 61 were used to calculate emissions due to exposure of radioactive material to the atmosphere during processing or handling. Additional emissions resulting from the release of radionuclide-contaminated particles through handling or processing soil and debris were based on emission factors in EPA's *Compilation of Air Pollutant Emission Factors,* AP-42 (EPA, 1995). Where appropriate, emission data from a DOE publication, *Airborne Release Fractions/Rates and Respirable*

Fractions for Nonreactor Nuclear Facilities (DOE, 1994), were also used. The appropriate emission factors were combined with information regarding the specific process or project to yield estimated radionuclide emissions.

In addition to emissions from specific projects or processes, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated surface soils by wind erosion. Emissions from this source were estimated by combining information regarding Site-wide surface soil concentrations of radionuclide contaminants with a Site-specific soil resuspension factor. The development of the Site-specific soil resuspension factor used in emission calculations was discussed in detail in a previous annual report (DOE, 1996).

Historical surface soil radionuclide concentration data from a Site-specific soil sampling database were used to develop a set of radionuclide concentration isopleths spanning the entire Site. The soil resuspension emissions reflect information based on plutonium and americium concentration isopleths that were updated in 1999 and uranium concentration isopleths that were updated in 1998.

The emissions discussed in this section include the isotopes that have the potential to contribute 10% or more to the Site's total air pathway EDE. These include:

- Uranium isotopes typical of the depleted and enriched uranium that have been used at the Site, as well as uranium isotopes that are naturally present in Site soils;
- Pu-239/240, which contributes more than 97% of the alpha activity in Site plutonium; and
- Am-241, a decay product of Pu-241, which is a minor component of the weapons-grade plutonium used at the Site.

Historically, tritium emissions from the Site have also been reported. However, as indicated in the calendar year 2000 annual report (DOE, 2001), because potential tritium emissions from the Site have decreased to negligible levels in recent years, tritium is no longer reported.

3.2 Point Sources

Radionuclide emissions released through stacks and vents are termed "point" sources. In 2001, radionuclide point source emissions at the Site included both measured releases from stacks and vents in the industrial area and releases that were estimated as described in Section 3.1. Point source emissions for calendar year 2001 and the control technology used at each point source are described in this section.

3.2.1 Measured Point Source Emissions

During calendar year 2001, radionuclide emissions were collected and measured only at significant release points. Significant release points are those that have the potential to discharge radionuclides into the air in quantities that would result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration). Insignificant release points are those that have the potential to discharge radionuclides in lesser quantities. Significant release points must be continuously monitored or sampled, while insignificant release points require periodic confirmatory measurements to verify low emissions (40 CFR 61.93).

Prior to 1999, periodic confirmatory measurements to verify low emissions were made at the insignificant release points using the effluent sampling systems described below. Effluent sampling was discontinued at insignificant locations in 1999 and 2000, and the compliance sampling network (an ambient air monitoring network that is described in Section 4.1.1) has been used since then to confirm low emissions.

Effluent Sampling Methods

Point source emissions are measured at the Site with a sampling system that continuously draws a portion of the duct or vent airstream through a filter. Radioactive particles collect on the filters, which were exchanged weekly in 2001. Following collection, the filters were screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples were composited monthly by location and analyzed for plutonium, americium, and uranium isotopes. All radionuclides that could contribute greater than 10% of the potential EDE for a release point were measured during calendar year 2001.

Calendar Year 2001 Effluent Sampling

Due to the complexity of the building ventilation systems at the Site, the number of sampling points used is not a one-to-one match with the number of release or emission points. In most cases, the effluent streams that are sampled correspond to a single release point. At some locations, however, the sampling location monitors an effluent stream that is released through multiple stacks or vents.

In calendar year 2001, particulate matter samples were collected at 25 routine sampling locations, representing 29 release points. Twenty of these locations were sampled all year. An additional five locations, representing nine release points, were sampled during a portion of the year. Appendix B lists the release points monitored in calendar year 2001.

Historically, particulate matter samples were collected at many release points that have been identified as insignificant. These locations, while not currently sampled, are still considered release points. However, the quantities of radionuclides emitted from these locations in 2001 were negligible, and low emissions from these points were verified using the ambient sampler network. Appendix C to the calendar year 2000 annual report (DOE, 2001) contains additional information regarding previously sampled insignificant release point locations.

During 2001, several changes in point source emission measurements took place. Samplers at four locations were reactivated to support decommissioning activities: 707-R21A/B, -R23A/B, -R24A/B, and -R25A/B. During decommissioning, these locations may have the potential to emit radionuclides into the air in quantities that could result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration).

Sampling continued throughout much of 2001 at Building 440 in anticipation of planned waste repackaging activities. Sampling was discontinued during a portion of the year due to power interruptions and while equipment was being repaired. No waste repackaging activities occurred during this time.

In calendar year 1997, 18 particulate sampling locations were upgraded from multi-point sampling systems to single-point shrouded probe sampling systems, as required by a 1994 agreement between DOE and EPA (Brockman, 1995). Single-point shrouded probe sampling systems were also installed at locations 371-N01, 371-N02, and 371-SSS, and were operated concurrently with the pre-existing multi-point sampling systems. Because the airflow patterns within the ducts in Building 371 did not produce uniform mixing, the shrouded probe samplers were turned off in September 2001 and the multi-point sampling system data have been used for this report.

Measured calendar year 2001 emissions of plutonium, americium, and uranium are shown in Table 3-1.

Appendix C shows calendar year 2001 measured point source emissions data that would historically have been contained in DOE's Effluent Information System (EIS)/Off-Site Discharge Information System (ODIS). DOE did not publish an EIS/ODIS report for 2001.

3.2.2 Calculated Point Source Emissions

During 2001, several point sources operated at the Site that did not trigger continuous sampling requirements because they had low emission potential or were of short duration. These sources included emissions from a drum crusher in Tent 5 at the 750 Pad, which

Table 3-1. Measured Point Source Radionuclide Emissions

Building/ Location[a]	Isotope Emissions (Ci/yr) [b,c,d]				
	Pu-239/240	Am-241	U-233/234	U/235	U-238
371-N01	4.4E-09	3.0E-09	5.2E-10	2.0E-09	5.2E-09
371-N02	2.7E-09	5.4E-10	8.5E-09	3.5E-10	1.3E-09
371-SSS	1.0E-09	3.5E-10	2.7E-09	0	4.0E-10
374-MAI	1.3E-09	5.1E-09	6.4E-09	9.4E-10	5.7E-09
440-101[e]	5.7E-10	3.3E-10	6.0E-10	1.9E-11	1.7E-09
559-561	0	3.2E-09	0	7.8E-10	6.6E-09
707-101/103	4.2E-11	5.4E-11	2.2E-10	4.0E-11	1.4E-10
707-102/104	7.4E-11	7.7E-11	1.4E-10	8.0E-11	6.8E-10
707-105	0	1.2E-10	1.9E-09	0	2.6E-10
707-106	1.6E-10	5.4E-11	4.6E-10	2.8E-11	2.8E-10
707-107	9.4E-10	9.7E-10	4.5E-09	0	2.5E-09
707-108	2.0E-10	0	1.3E-09	3.4E-10	3.1E-10
707-R21A/B[f]	9.2E-10	6.2E-10	2.4E-09	0	1.1E-09
707-R23A/B[f]	5.7E-10	6.8E-12	1.3E-09	3.5E-10	2.8E-10
707-R24A/B[g]	5.3E-10	2.7E-10	3.3E-09	0	1.1E-09
707-R25A/B[h]	1.5E-09	2.0E-10	6.5E-11	0	5.8E-10
771-MAI	1.8E-09	6.4E-09	1.7E-08	1.6E-08	2.0E-08
774-202	3.1E-10	7.8E-11	2.0E-09	8.9E-11	1.0E-10
776-201	4.5E-12	6.4E-12	3.3E-10	3.6E-11	3.6E-10
776-202	3.1E-10	1.2E-10	0	1.8E-10	6.4E-10
776-204	3.1E-09	8.4E-10	3.0E-09	0	4.8E-10
776-205	2.4E-09	6.3E-10	9.5E-10	1.5E-09	4.3E-09
776-250	4.6E-08	0	1.0E-07	2.2E-08	7.4E-08
776-251	2.4E-09	2.0E-09	0	0	1.5E-09
776-252	6.1E-10	1.8E-10	1.8E-10	0	1.4E-10

[a] The first number in this column designates the building cluster, the second set of characters designates the specific duct(s) or vent(s). The location of each release point is shown in Figure 3-1 of this report.
[b] Values were corrected for filter blanks.
[c] All measured point sources were controlled by HEPA filters with a tested control efficiency of at least 99.97 percent.
[d] All isotopes that could contribute greater than 10% of the potential EDE for a release point were measured.
[e] Release point 440-101 was inactive during a portion of the year (see discussion in Section 3.2.1).
[f] Samplers reactivated on 11/05/01.
[g] Sampler reactivated on 8/06/01.
[h] Sampler reactivated on 10/01/01.

Notes:

Am	=	Americium
Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E#	=	x $10^{\#}$
EDE	=	Effective dose equivalent
HEPA	=	High efficiency particulate air
Pu	=	Plutonium
U	=	Uranium

was described in Section 2.2.2. Point sources with calculated emissions that continued operation from 2000 are described below.

Emissions were calculated for these insignificant release points as described in Section 3.1. Table 3-2 shows calculated point source emission estimates for calendar year 2001.

904 Pad, Tent 11 Repackaging of Waste Chemicals: In 1999, 2000, and 2001, drums of waste chemicals were repackaged in the Tent 11 containment structure on the 904 Pad. The drums were evaluated, characterized, and repackaged for off-Site disposal, or returned to on-Site storage.

The permacon air exhausted through two stages of HEPA filters. Emission estimates for this project were based on the conservative assumption that all drums were at the maximum allowable concentration for low-level waste (100 nanocuries plutonium per gram waste), and on the assumption that there would be 20 drums within the permacon open to the atmosphere at all times.

Unmonitored Building Stacks and Vents: Small amounts of radionuclides continued to be released from various building stacks and vents that have been classified as insignificant release points. Individually, none of these release points had the potential to release radionuclides in amounts that could result in an off-Site EDE in excess of 1% of the 10 mrem standard, even if the emissions were uncontrolled. Many of these release points were controlled by two or more stages of HEPA filters; consequently, actual emissions would have been a fraction of a percent of the standard limitation. As a result, no attempt has been made to estimate emissions from these sources; instead, the compliance sampling network data have been used to demonstrate that none of these points released significant quantities of radionuclides during calendar year 2001 (see Section 4.1 of this report).

3.2.3 Control Technology for Point Sources

HEPA filters are used to control radioactive particulate matter emissions from air effluent systems. All of the point source locations listed in Table 3-1 used HEPA filtration in 2001. Air effluent from areas where plutonium or plutonium-contaminated wastes were processed was typically cleaned by a minimum of four stages of HEPA filters. Air effluent from uranium processing areas was generally cleaned by a minimum of two stages of HEPA filters. HEPA filters were bench tested prior to installation in the buildings to ensure that they would meet a minimum filter efficiency of 99.97% (Novick, et al., 1985). Filter assemblies were tested again for leaks following installation.

Table 3-2. Calculated Point Source Radionuclide Emissions

Activity or Building	Isotope Emissions (Ci/yr) [a]				
	Pu-239/ 240	Am-241	U-233/234	U-235	U-238
750 Pad, Tent 5 Drum Crusher[b]	4.7E-08	--	--	--	--
Building 374 Spray Dryer[b]	3.3E-08	--	--	--	--
904 Pad, Tent 11 Waste Chemical Repackaging[b]	2.2E-06	2.3E-07	--	--	--

[a] Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. Isotopes for which emissions were not estimated are shown as "--". The locations of the release points listed are shown in Figure 3-1 of this report.

[b] HEPA filtration used with a control efficiency of at least 99.97 percent.

Notes:

Am = Americium
Ci/yr = Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E# = x $10^{\#}$
EDE = Effective dose equivalent
HEPA = High efficiency particulate air
Pu = Plutonium
U = Uranium
-- = Not estimated/negligible

Waste repackaging activities at the 904 Pad, Tent 11, and the Building 374 spray dryer were controlled by two stages of HEPA filters. The drum crushing activities at the 750 Pad, Tent 5 were controlled by a single-stage HEPA filter.

3.3 Nonpoint Sources

Radionuclide emissions that are not released through specific stacks or vents are termed "nonpoint" (or diffuse) sources. In calendar year 2001, nonpoint sources of radionuclide emissions at the Site included resuspension of contaminated soils by wind erosion and by mechanical disturbance due to excavation, handling, and vehicle traffic. Mechanical disturbance of contaminated soils was associated with:

- 750 Pad asphalt repair;
- Installation of fork truck paths and trailer pads at Building 664; and
- Installation of surface water monitoring stations southeast of the 903 Pad.

Calendar year 2001 nonpoint sources also included the Building 111 demolition project. Radionuclide emissions were measured by an ambient network activated for the Building 111 demolition and were found to be negligible.

Several other structures were demolished during 2001, including Buildings 333, 762, 762A, 792, 792A, and 888; Guard Towers 550, 761, and 901; Cooling Towers 709, 560, 712, 373, and 713; and Trailers 883A, 883B, 551A, 891B, and 331A. These structures were not radiologically contaminated. Therefore, no radionuclide emissions were calculated for these demolition projects.

Nonpoint sources with emissions that continued from 2000, and methods used to minimize nonpoint source emissions, are described below. Table 3-3 summarizes emissions from nonpoint sources for calendar year 2001.

3.3.1 Nonpoint Source Descriptions

Resuspension of Contaminated Soils by Wind Erosion: As described in Section 3.1, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated soil. Calendar year 2001 emissions from wind erosion of contaminated soil are summarized in Table 3-3.

Table 3-3. Nonpoint Source Radionuclide Emissions

Source or Project[b]	Isotope Emissions (Ci/yr)[a]				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
Resuspension by Wind Erosion[c]	4.8E-05	1.5E-05	2.2E-07	3.2E-08	1.5E-07
750 Pad Asphalt Repair	6.4E-08	4.8E-09	3.9E-08	3.1E-09	1.3E-08
Building 664 Fork Truck Paths/Trailer Pads	1.4E-05	1.1E-06	8.6E-06	6.7E-07	2.9E-06
Surface Water Monitor Installations	6.4E-06	4.8E-07	3.9E-06	3.5E-07	1.3E-06

[a] Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. The locations of the nonpoint release emission sources are shown in Figures 3-1 through 3-6 of this report.
[b] Emissions assumed to be uncontrolled.
[c] Based on 1998 and 1999 soil isopleth data.

Notes:

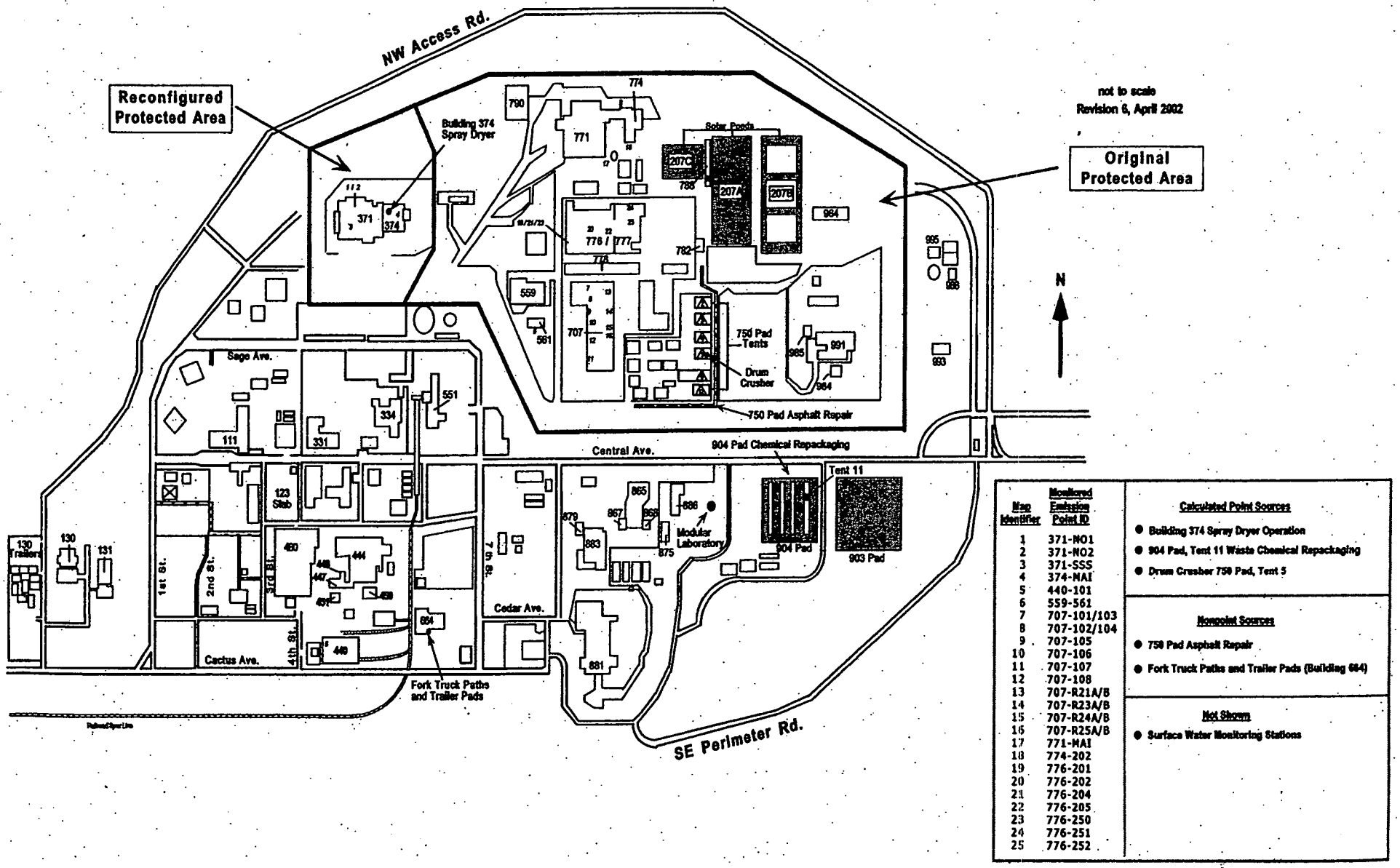
Am	=	Americium
Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E#	=	x$10^{\#}$
EDE	=	Effective dose equivalent
Pu	=	Plutonium
U	=	Uranium

3.3.2 Control Technology for Nonpoint Sources

Particulate emissions from significant earth-moving activities at the Site and from decommissioning activities were controlled by water spray or other dust suppression measures, with an estimated control efficiency of 50 percent. Fugitive dust control plans that specify the control measures to be used to minimize emissions of contaminated dust are developed for each project with the potential to generate significant radionuclide emissions from soil or debris handling, or from demolition activities. For calendar year 2001, the projects listed in Section 3.3 that involved relatively minor earth-moving or debris-handling activities, such as repair and maintenance operations, were assumed to be uncontrolled.

3.4 Release Locations

Figure 3-1 shows the location of various emission sources listed in Tables 3-1 through 3-3. Figures 3-2 through 3-6 show source areas for wind erosion of radionuclides.



Map Identifier	Monitored Emission Point ID
1	371-NO1
2	371-NO2
3	371-SSS
4	374-MAI
5	440-101
6	559-561
7	707-101/103
8	707-102/104
9	707-105
10	707-106
11	707-107
12	707-108
13	707-R21A/B
14	707-R23A/B
15	707-R24A/B
16	707-R25A/B
17	771-MAI
18	774-202
19	776-201
20	776-202
21	776-204
22	776-205
23	776-250
24	776-251
25	776-252

Calculated Point Sources

- Building 374 Spray Dryer Operation
- 904 Pad, Tent 11 Waste Chemical Repackaging
- Drum Crusher 750 Pad, Tent 5

Nonpoint Sources

- 750 Pad Asphalt Repair
- Fork Truck Paths and Trailer Pads (Building 664)

Not Shown

- Surface Water Monitoring Stations

Figure 3-1. Industrial Area Source Locations

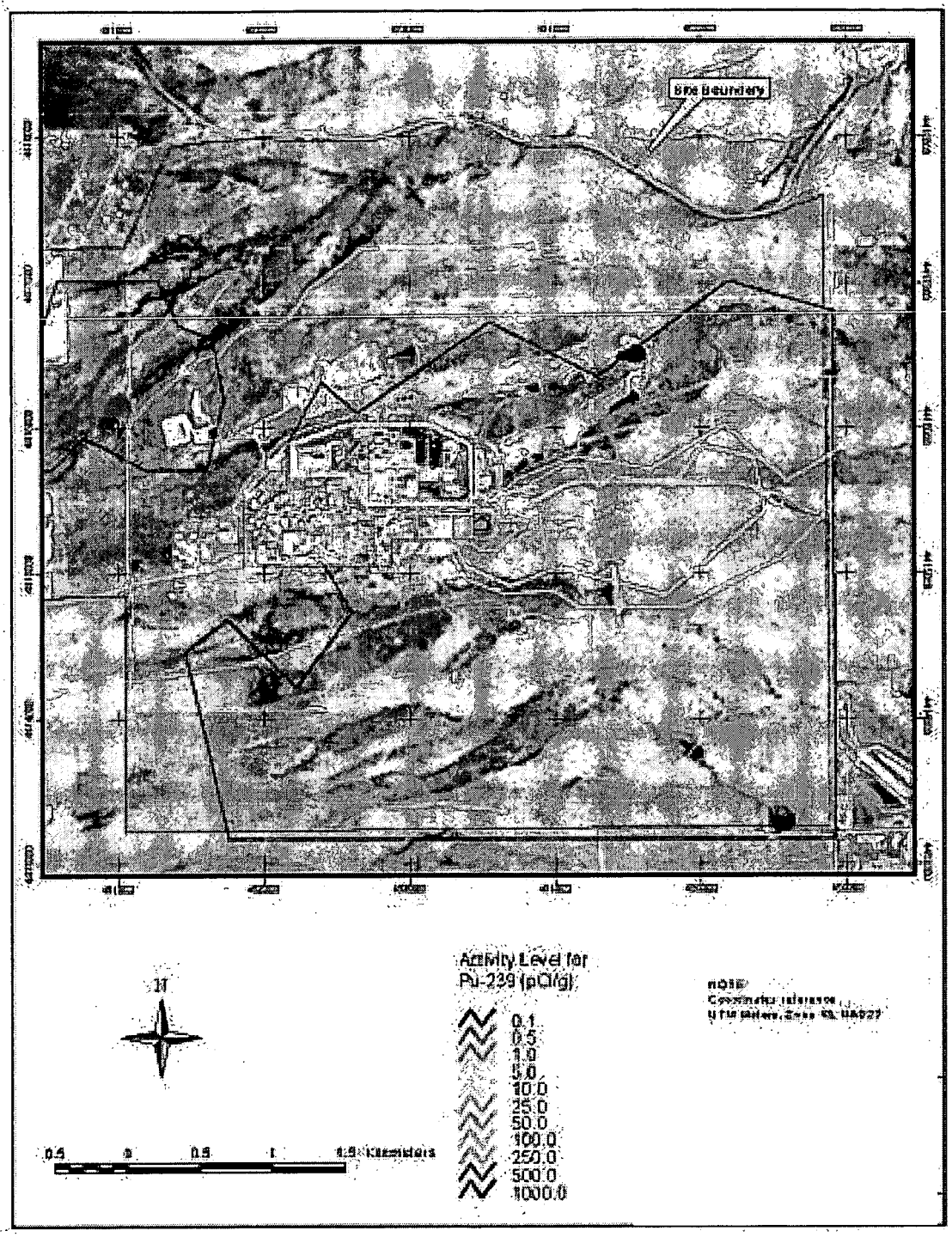


Figure 3-2. Surface Soil Contamination Isopleths for Pu-239/240

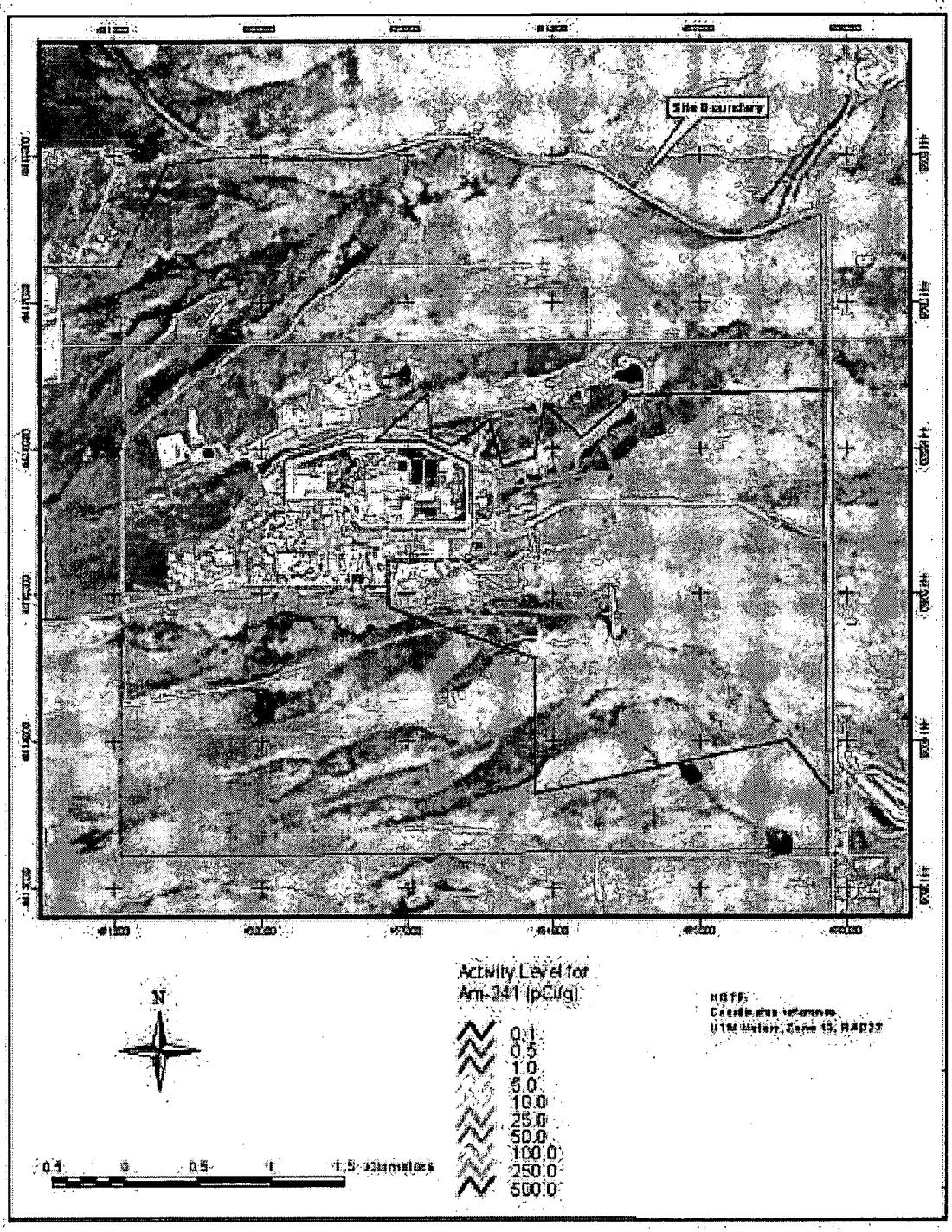


Figure 3-3. Surface Soil Contamination Isopleths for Am-241

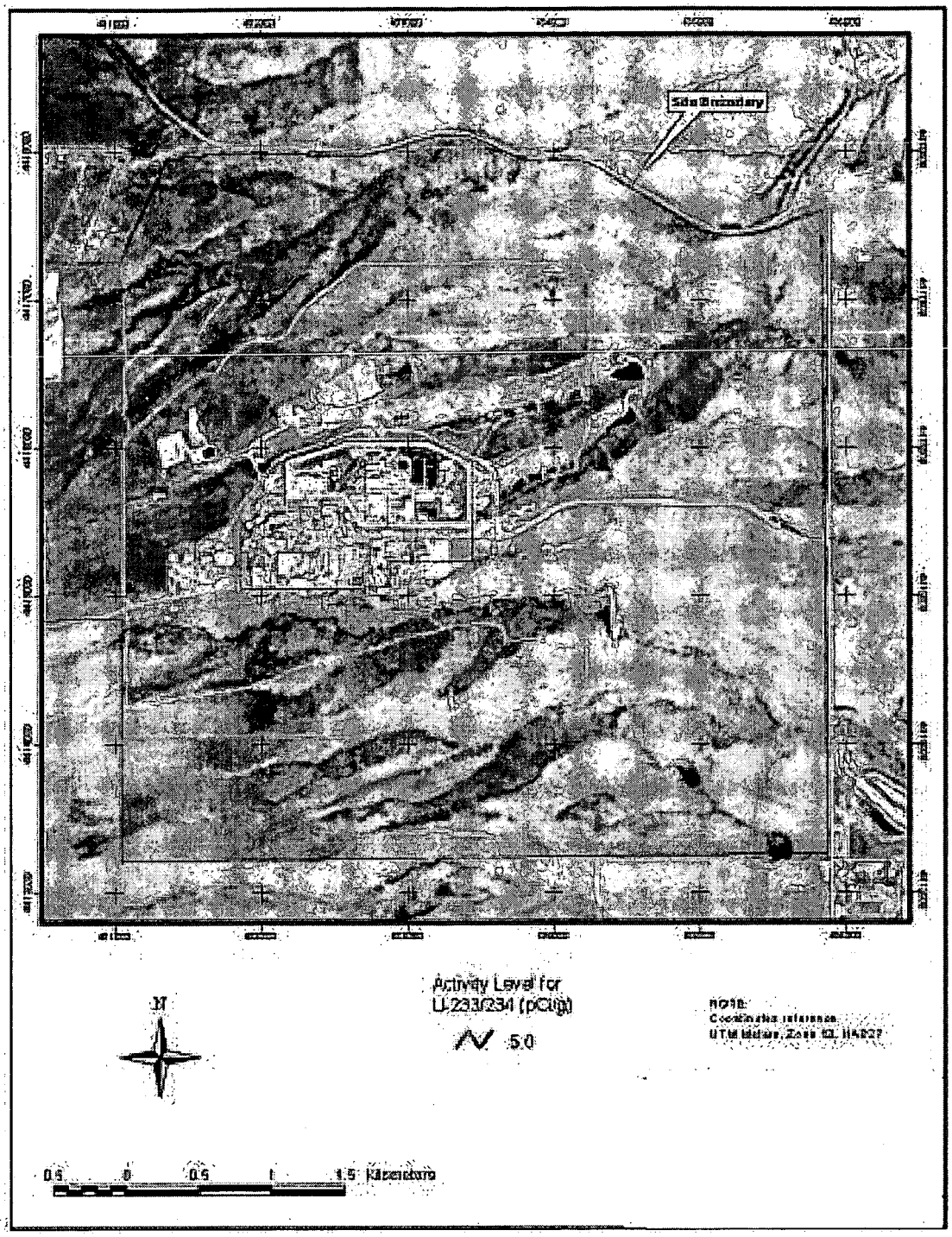


Figure 3-4. Surface Soil Contamination Isopleths for U-233/234

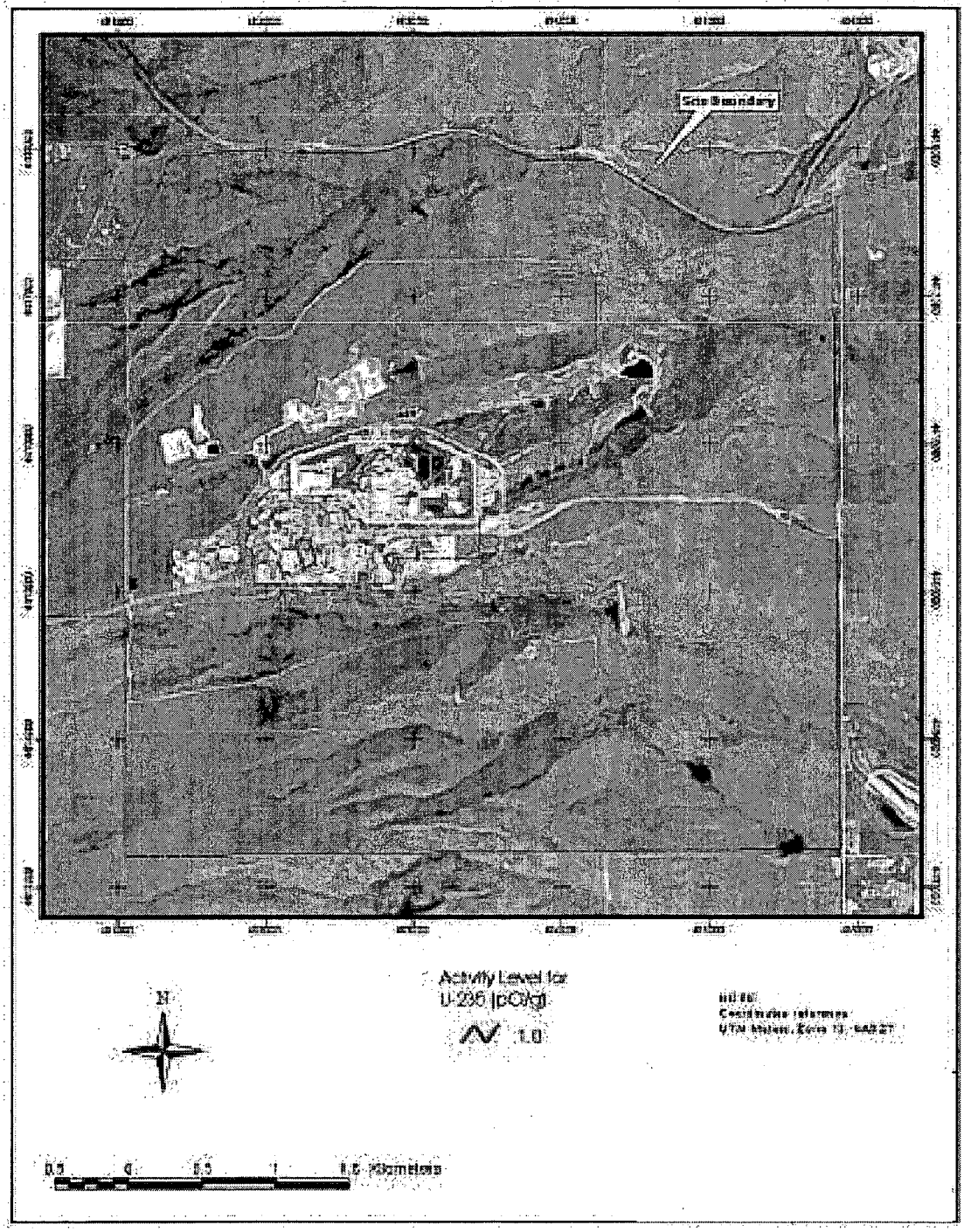


Figure 3-5. Surface Soil Contamination Isopleths for U-235

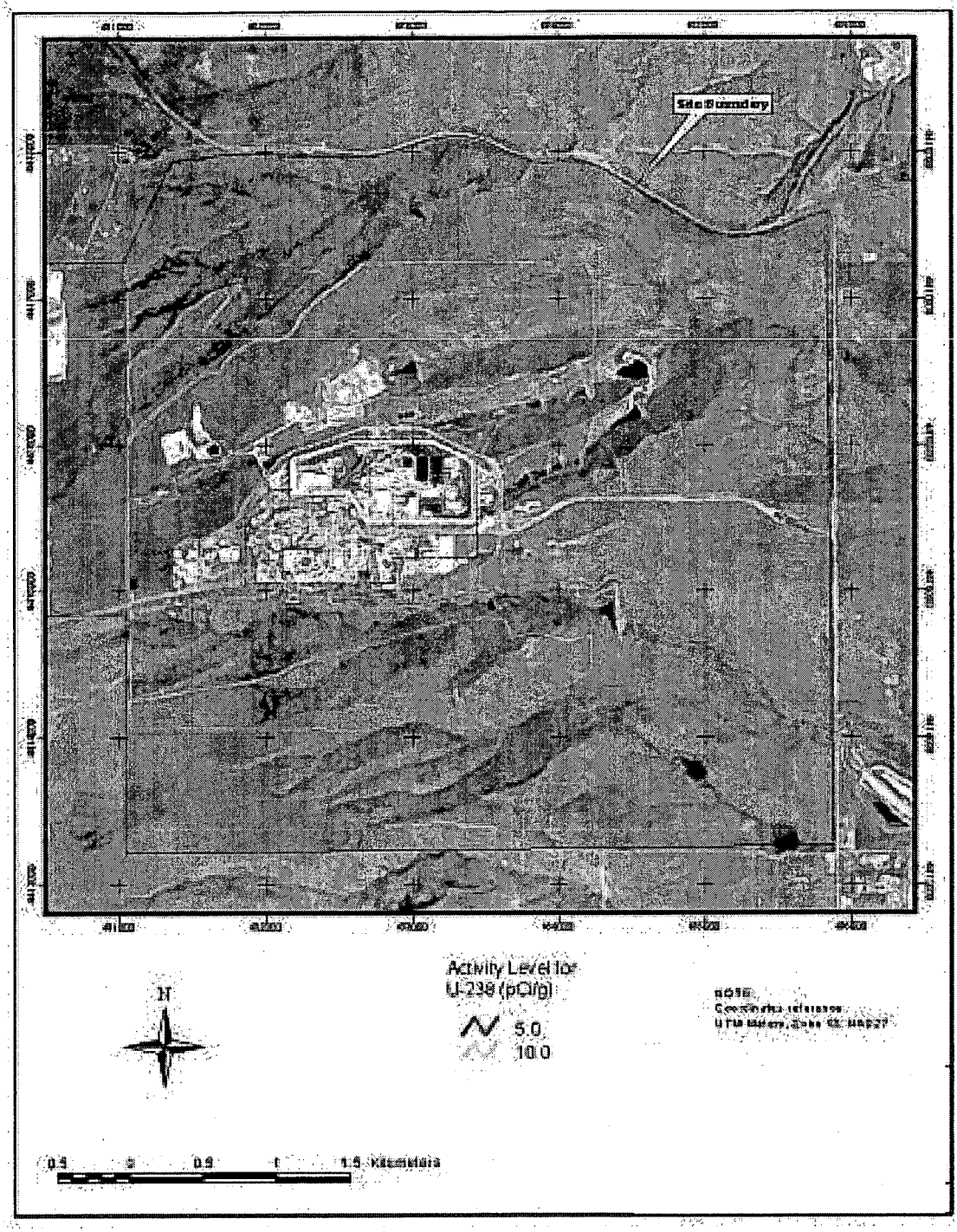


Figure 3-6. Surface Soil Contamination Isopleths for U-238

4.0 COMPLIANCE ASSESSMENT

This section describes the compliance assessment performed for the Site for the 2001 calendar year.

4.1 Compliance Demonstration Based on Environmental Measurements

Historically, the Site has demonstrated compliance with the annual 10-mrem public dose standard in 40 CFR 61, Subpart H, through measurement and dispersion modeling of the measured point source emissions, and emission estimation and dispersion modeling of the nonpoint and calculated point source emissions, to determine the dose to the most impacted off-Site resident. Beginning with calendar year 1998, the Site transitioned to an alternative compliance demonstration method based on environmental measurements, as allowed by 40 CFR 61.93(b)(5). The calendar year 2001 compliance assessment is based on the alternative method, which is described below.

4.1.1 Description of Compliance Sampling Network

The Site operates a network of environmental air samplers (the RAAMP network) that consists of 39 high-volume, size-fractionating ambient air samplers located on and around the Site, and in nearby communities. The compliance sampling network consists of 14 of these samplers located along the Site perimeter. Eleven of these samplers have operated for several years in their current locations. A 12th sampler located at the intersection of Highway 72 and Indiana Street ceased operation and a new sampler began operation to the north along Indiana Street during 1999. In addition, two new samplers were installed during 1999 to complete the compliance sampling network, one at the northeast corner of the Site fenceline near the intersection of Highway 128 and Indiana Street and the other due north of the center of the Site, on South 66th Street. The compliance sampling network is shown in Figure 4-1, along with nearby businesses or residences (receptors).

The ambient air samplers continuously collect both fine and coarse particulate matter fractions on filters and removable impactor surfaces that are exchanged and analyzed on a monthly schedule. The samples are analyzed for the plutonium, americium, and uranium isotopes that represent most of the radioactive materials handled at or residing on the Site. These isotopes account for all materials that have the potential to contribute 10% or more of the dose to the public.

Residential and commercial development on and around the Site is reviewed on a quarterly basis. If new development or privatization projects warrant additional or revised sampler locations, EPA and CDPHE will be notified. Sampler installation will be scheduled so that samplers will be operational when the new residence or business is

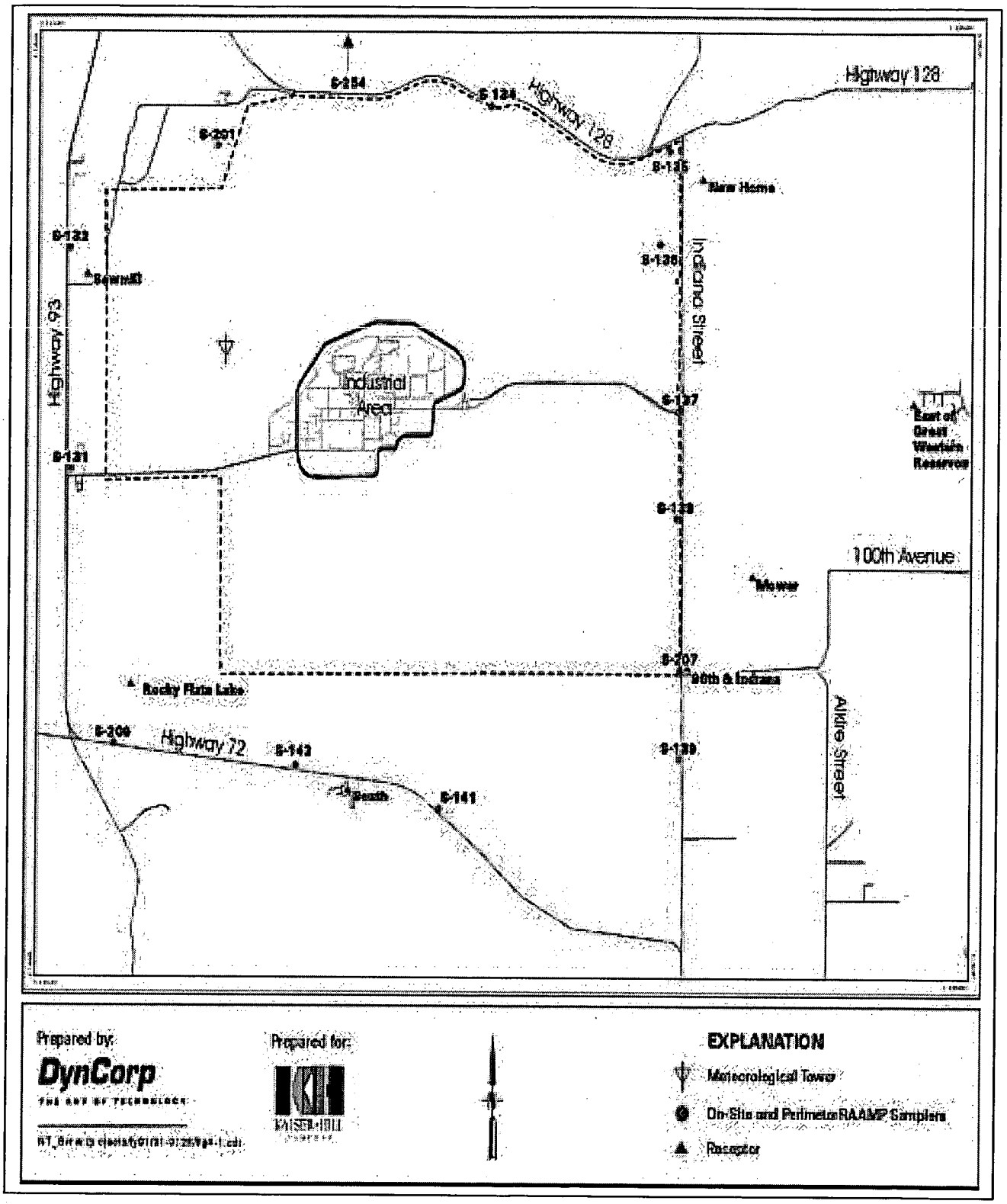


Figure 4-1. Receptor Locations and Nearby Samplers

occupied. No development that warranted additional or revised sampler location occurred in calendar year 2001.

Following the transition to the alternative compliance demonstration method, effluent collection and measurement were discontinued for insignificant release points on Site and the ambient network is now used to verify low emissions from these locations, as required by Section 61.93(b)(4). Emissions from significant release points will continue to be measured with the existing effluent sampling systems. These effluent samplers will remain operational until the buildings are actively being decommissioned or until the operations that exceeded the 0.1 mrem trigger have ceased.

4.1.2 Compliance Sampling Network Measurements for 2001

Filters from the compliance sampling network were exchanged monthly during 2001, then analyzed for Pu-239/240, Am-241, U-233/234, U-235, and U-238. These isotopes accounted for all materials that had the potential to contribute 10% or more of the dose to the public. Annual average isotopic concentrations were calculated at each sampler from the monthly concentration and air volume data. The annual average isotopic concentrations for each of the compliance demonstration samplers are shown in Table 4-1.

A *fractional sum* was calculated for each sampler location by dividing each annual isotopic concentration by that isotope's corresponding *compliance level* as listed in Table 2 of Appendix E to 40 CFR 61, then summing the fractions. The fractional sums are also shown in Table 4-1.

4.2 Compliance Assessment Results

This section discusses the results of the compliance assessment for calendar year 2001.

4.2.1 Compliance Demonstration

As reported in Section 4.1 of this report, the maximum annual concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 measured at the compliance sampling network were compared to the compliance levels listed in Table 2 of Appendix E to 40 CFR 61. In each case, the maximum measured concentration of each isotope, as shown in Table 4-1, was less than 1% of the corresponding compliance level. In addition, the fractional sum of all isotopes at the *critical receptor* location (the sampler showing the highest concentrations in 2001) was determined to be 0.0128. The facility is in compliance when the annual concentration of each isotope is less than its corresponding Table 2 compliance level and when the fractional sum of all isotopes is less than 1.

Table 4-1. Annual Average Isotopic Concentrations at Compliance Sampling Network Locations

Sampler	Pu-239/240 (Ci/m^3)	Am-241 (Ci/m^3)	U-233/234 (Ci/m^3)	U-235 (Ci/m^3)	U-238 (Ci/m^3)	Fractional Sum
S-131	6.3E-19	3.4E-19	2.8E-17	1.3E-18	2.8E-17	0.0080
S-132	2.0E-19	3.8E-19	4.7E-17	2.5E-18	4.6E-17	**0.0128**
S-134	1.3E-19	1.3E-19	2.2E-17	1.1E-18	2.0E-17	0.0059
S-135	2.7E-19	3.0E-20	2.5E-17	1.3E-18	2.4E-17	0.0068
S-136	5.7E-19	2.9E-19	2.1E-17	9.5E-19	1.9E-17	0.0058
S-137	4.6E-19	1.7E-19	2.5E-17	1.2E-18	2.3E-17	0.0068
S-138	2.2E-18	3.3E-19	2.3E-17	1.2E-18	2.4E-17	0.0075
S-139	3.9E-20	3.9E-20	3.2E-17	1.8E-18	3.2E-17	0.0089
S-141	4.6E-19	9.0E-20	3.8E-17	2.2E-18	3.4E-17	0.0010
S-142	3.7E-19	0.0E-00	2.6E-17	1.3E-18	2.6E-17	0.0072
S-201	8.5E-20	1.3E-19	2.9E-17	1.7E-18	2.7E-17	0.0078
S-207	2.2E-19	3.3E-20	3.0E-17	1.8E-18	3.1E-17	0.0083
S-209	5.4E-19	8.5E-20	2.6E-17	1.4E-18	2.7E-17	0.0074
S-254	7.0E-20	1.3E-19	4.3E-17	1.8E-18	4.0E-17	0.0011
Compliance Level (Ci/m^3)[a]	**2.0E-15**	**1.9E-15**	**7.1/7.7E-15**	**7.1E-15**	**8.3E-15**	**1**

[a] Compliance levels are listed for each isotope in Table 2 of Appendix E to 40 CFR 61.

Notes:

Am = Americium
Ci/m^3 = Curies per cubic meter; 1 Ci = 3.7×10^{10} Becquerel (Bq)
E# = $\times 10^{\#}$
Pu = Plutonium
U = Uranium

Figure 4-2 shows data from the 2001 compliance sampling network at all locations. The data are presented as percentages of the compliance level for each isotope; the total height of each bar in Figure 4-2 represents the fractional sum expressed as a percent of the allowable sum (percent of 1). Data are presented for each sampler, beginning with S-131 at the west gate of the Site, and continuing around the Site perimeter in a clockwise direction. Sampler locations are shown in Figure 4-1.

The maximum measured radionuclide levels occurred to the northwest of the Site, at sampler S-132. This location also showed the highest radionuclide levels measured at the perimeter samplers during calendar years 1997, 1998, 1999, and 2000.

Examination of the isotopic data presented in Table 4-1 and Figure 4-2 shows that the higher overall radionuclide level (fractional sum) at S-132, relative to other samplers in the compliance sampling network, was primarily due to higher levels of U-233/234 and U-238. The ratio of U-233/234 to U-238 activities at S-132 (and at other compliance samplers as well) was close to 1:1, which is characteristic of naturally occurring

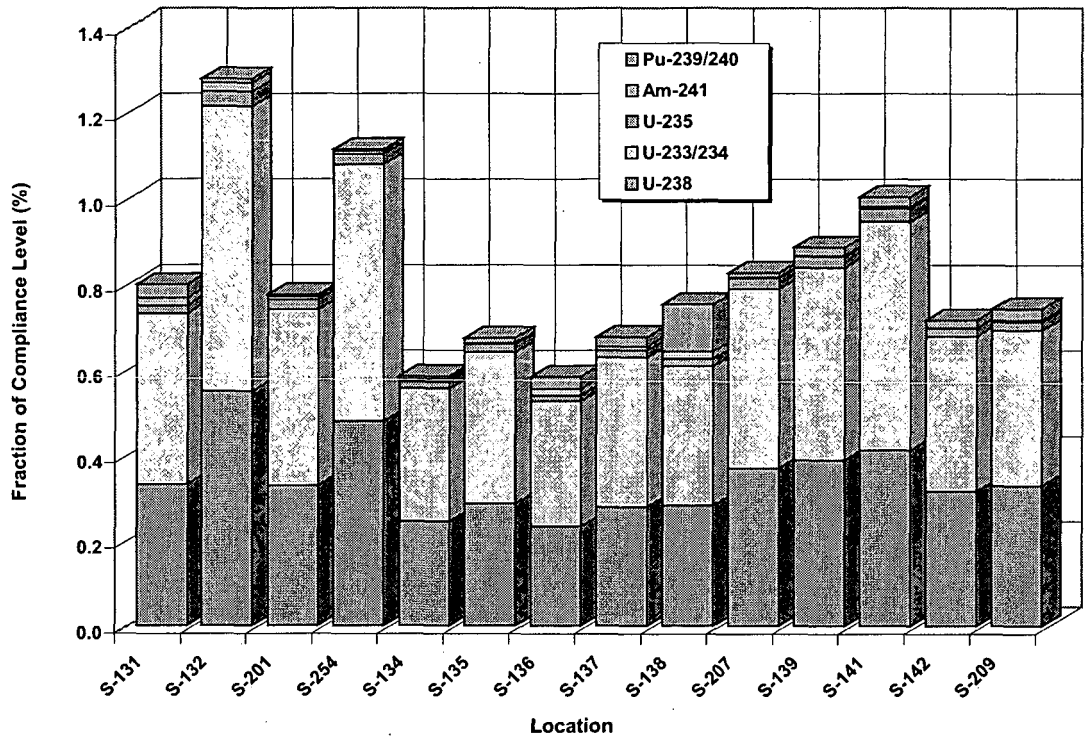


Figure 4-2. Environmental Measurements of Airborne Radionuclides in 2001

uranium. (In contrast, depleted or enriched uranium that might be emitted from on-Site sources would show different isotopic ratios.) S-132 is located in an area that has elevated dust levels due to quarrying activities, sand and gravel removal, and turbulence caused by nearby traffic. The soils surrounding Rocky Flats contain naturally occurring uranium, which may explain the elevated activities at this sampler. Figure 4-3 shows the isotopic breakdown at S-132 as a percentage of the total fractional sum at that location; approximately 95% of the fractional sum is due to U-233/234 and U-238.

Naturally occurring uranium isotopes appear to have dominated the airborne radionuclide levels at all the compliance samplers in 2001. For example, the sum of U-233/234 and U-238 activity represented 81% of the fractional sum at S-138 and exceeded 90% of the fractional sum at all other compliance demonstration samplers in 2001.

Figure 4-4 shows the measured levels of Pu-239/240 and Am-241 at the compliance sampling network locations, also presented as percentages of the compliance level for each isotope. These two isotopes are characteristic of the weapons-grade plutonium used at the Site.

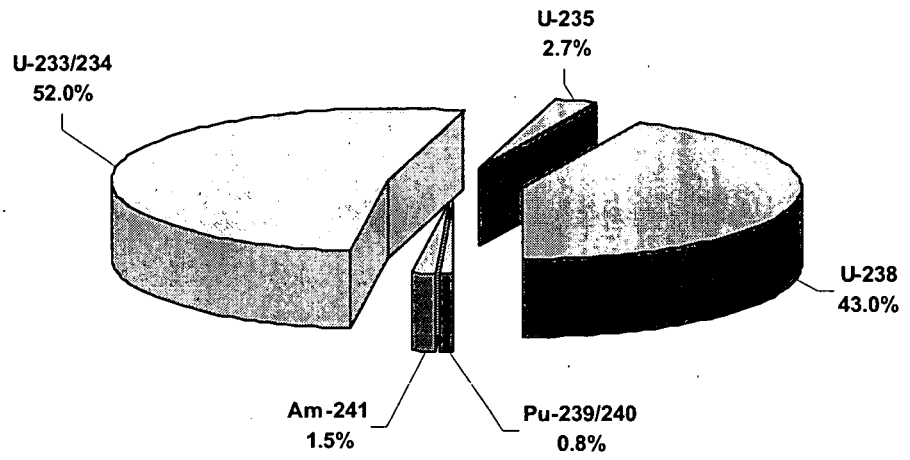


Figure 4-3. Isotopic Contribution to the Fractional Sum at the Critical Receptor

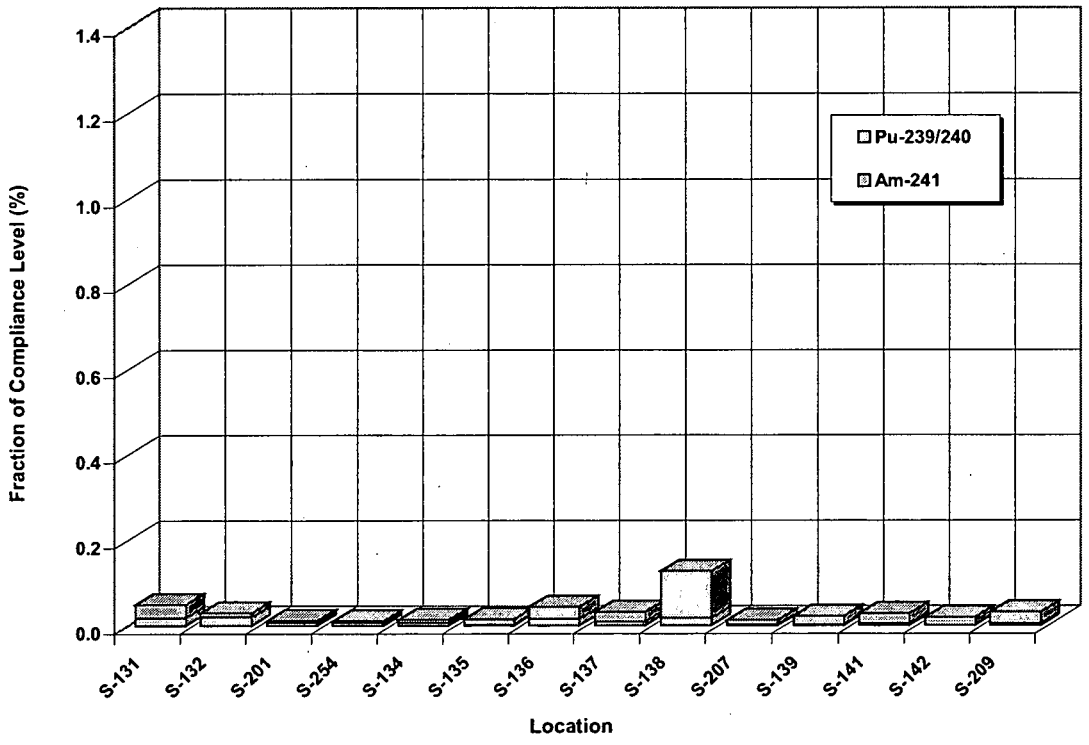


Figure 4-4. Environmental Measurements of Pu-239/240 and Am-241 in 2001

As has been seen in past years, Pu-239/240 and Am-241 present a different pattern than U-233/234 and U-238. An increase in concentrations is apparent at one of the samplers on the eastern boundary of the Site, S-138; concentrations at other perimeter samplers show no discernable patterns. Based on annual average wind patterns (see Appendix D), S-138 is generally downwind of the 903 Pad and surrounding areas, which have represented a major source of plutonium and americium emissions from the Site in recent years due to resuspension of contaminated surface soils. This sampler is also downwind of the industrial area, where increases in emissions may have occurred in 2001 due to decommissioning and demolition activities, with their attendant disturbance of surface dust and debris.

Most of the increased Pu-239/240 activity at S-138 occurred in the March 2001 sample from that location. The increased activity could not be directly correlated with project activities or nearby soil disturbances, although a number of construction and demolition activities occurred in that time frame, both on Site and off Site. March was also relatively windy, with periods with gusts exceeding 40 miles per hour (mph) occurring several times during the month, and the pattern of high winds supports transport of resuspended Site soil towards S-138, which is a common pattern at the Site. Note that although the Pu-239/240 activity levels recorded at S-138 in March 2001 were higher than those seen at other samplers during 2001, they still represent an annual dose rate two orders of magnitude below the 10 mrem standard.

The fractional sum information for calendar year 2001 for the critical receptor can be compared with the 10-mrem dose limit and with data from prior years. As noted previously, the fractional sum at the critical receptor location in 2001 was 0.0128, which is nearly two orders of magnitude below the allowable level (fractional sum of 1). The fractional sum can be directly related to the allowable dose limit of 10 mrem in 40 CFR 61, Subpart H. As a result, the maximum dose recorded at the compliance sampling network in 2001 was nearly two orders of magnitude below the 10-mrem limit and approximately 95% of the dose was due to uranium isotopes that are largely naturally occurring in the Site environment. For comparison, the fractional sum at the critical receptor was 0.0130 in 2000, 0.0145 in 1999, 0.0141 in 1998, and 0.0128 in 1997.

4.2.2 Statement of Compliance Status

Compliance with the 10-mrem standard has been determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when each measured radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2001, each measured radionuclide air concentration was less than 1% of its corresponding compliance level and the fractional sum of all radionuclides was less than 1.5% of the allowable level at

the critical receptor (the sampler with the highest fractional sum). The Site was in compliance with the 10-mrem standard during 2001.

4.3 Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See 18 USC 1001.)

Joseph A. Legare	David C. Shelton
Assistant Manager	Vice President
of Environment and	of Environmental Systems and
Infrastructure	Stewardship
Department of Energy	Kaiser-Hill Company, L.L.C.
Joseph A. Legare 6/19/02	David C. Shelton 6/12/02
Signature Date	Signature Date

5.0 SUPPLEMENTAL INFORMATION

The following information is provided pursuant to DOE guidance or EPA request and is not required by 40 CFR 61, Subpart H, reporting requirements.

- **Calendar year 2001 collective dose:** DOE facilities such as the Site are required to estimate the collective dose to the surrounding population on an annual basis by DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. While not a requirement of 40 CFR 61, Subpart H, the collective dose calculation for the air pathway has typically been reported in this annual report. Collective dose is defined as the sum of the EDEs of all individuals in an exposed population within an 80-km radius of the center of the Site (DOE, 1990).

  For calendar year 2001, the population distributions that form the basis of the collective dose calculation were updated. Estimated population growth figures for 2000 to 2001 were obtained for the counties located within 80 km of the Site from the State of Colorado, Department of Local Affairs, Demography Section. Similar estimates were obtained for counties comprising the metropolitan Denver area from the Denver Regional Council of Governments (DRCOG). Where two growth projections were obtained for a single county, the projections were averaged. Percentage growth estimates were applied to 2000 census data for each census tract within 80 km of the Site to obtain 2001 population values for modeling.

  The collective dose was calculated with CAP88-PC, as described in Appendix E. The collective dose for calendar year 2001 was 0.34 person-rem (0.0034 person-Sv).

- **Other radionuclide regulations:** 40 CFR 61, Subparts T and Q (CAQCC Regulation No. 8, Part A, Subparts T and Q) are not applicable to this Site. Subparts T and Q contain standards for radon emissions from specific facilities.

- **Unplanned releases:** There were no unplanned releases of radionuclides to the atmosphere from the Site during 2001.

- **Special Project Monitoring:** The compliance sampling network described in Section 4.1.1 is used to verify low emissions from Site insignificant release points and to demonstrate compliance with the 10 mrem annual limit in 40 CFR 61.92. However, ambient monitoring is also implemented at the Site for purposes that go beyond the specific requirements of 40 CFR 61, Subpart H. The RAAMP program is used to detect and track the impacts of Site operations on air quality to both protect and inform the public. Data are used to plan, implement, and assess the effects of on-Site activities. To supplement routine RAAMP network

operation in tracking emissions from decommissioning or remediation activities, the Site has established a special project monitoring program, as described below.

During execution of those portions of decommissioning and environmental restoration projects that have a significant potential to release fugitive radionuclide emissions, routine RAAMP operations are augmented by more frequent sampling using selected RAAMP samplers located in the immediate vicinity of the project or projects (rather than at the Site fenceline). Filters from these interior samplers are exchanged weekly instead of monthly. The filters are screened through an expedited gross alpha/beta count and the results compared to two predefined action levels specific to each project area and sampler.

The lower action level, which corresponds to a 1 mrem off-Site dose rate (should emissions continue at those levels for a full year), is used to determine when filters will be submitted for expedited isotopic analyses. If this action level is exceeded, project personnel will be contacted regarding possibly unexpected conditions and to determine whether additional sample collection and analysis may be warranted. If the higher action level, which corresponds to a 5 mrem off-Site dose rate, is exceeded, the weekly filters from the project-specific samplers will be submitted for expedited isotopic analyses. Project parameters will be reassessed and, if necessary, mitigative measures will be implemented to reduce future emissions.

The special project monitoring program for the Site is documented in an Integrated Monitoring Plan (Kaiser-Hill, 2000). The Integrated Monitoring Plan also describes monitoring of Site air emissions that is performed by CDPHE and additional monitoring that is coordinated by DOE.

6.0 REFERENCES CITED

Brockman, D. A. (U.S. Department of Energy), 1995. Letter. Rocky Flats Field Office, Golden, CO. February 27.

Kaiser-Hill Company, L.L.C., 2000. *FY 2001 Integrated Monitoring Plan.* Rocky Flats Field Office, Golden CO. November.

Novick, V.J., P.J. Higgins, B. Dierkschiede, C. Abrahamson, W.B. Richardson, P.R. Monson, and P.G. Ellison, 1985. "Efficiency and Mass Loading Characteristics of a Typical HEPA Filter Media Material" in *21st DOE/NRC Nuclear Air Cleaning Conference Proceedings.*

Roberts, Rick (Kaiser-Hill Company, L.L.C.), 1998. Personal Communication. June 16.

U.S. Department of Energy, 1990. Order 5400.5, *Radiation Protection of the Public and the Environment.*

U.S. Department of Energy, 1994. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities.* Volumes I and II. Washington D.C. December.

U.S. Department of Energy, 1996. *Radionuclide Air Emissions Annual Report for Calendar Year 1995.* Rocky Flats Field Office, Golden, CO. June.

U.S. Department of Energy, 1997. *Proposal to Use Environmental Sampling for Demonstrating Compliance with 40 CFR 61, Subpart H.* Rocky Flats Field Office, Golden, CO. July.

U.S. Department of Energy, 2001. *Radionuclide Air Emissions Annual Report for Calendar Year 2000.* Rocky Flats Field Office, Golden, CO. June.

U.S. Environmental Protection Agency, 1972. *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States.* Office of Air Programs, Research Triangle Park, NC. January.

U.S. Environmental Protection Agency, 1991. *Guidance on Implementing the Radionuclide NESHAPS.* Office of Radiation Programs, Washington, D.C. July.

U.S. Environmental Protection Agency, 1995. *Compilation of Air Pollutant Emission Factors.* Volumes I and II. Office of Air Quality Planning and Standards, Research Triangle Park, NC. January.

APPENDIX A

RADIOACTIVE MATERIALS ASSOCIATED WITH ROCKY FLATS

2. Traceable (Nonaccountable) Sources

Sealed solids < Appendix E values
Plated solids < Appendix E values
Liquids < 10^{-3} μCi

Americium (Am-241, 243)

Barium (Ba-133)

Bismuth (Bi-207, -210m)

Cadmium (Cd-109)

Californium (Cf-252, -250)

Carbon (C-14)

Cerium (Ce-139)

Cesium (Cs-137)

Chlorine (Cl-36)

Cobalt (Co-56, -57, -60)

Curium (Cm-244)

Europium (Eu-152, -154)

Gadolinium (Gd-148)

Hydrogen (Tritium) (H-3)

Iridium (Ir-192)

Iron (Fe-55)

Lead (Pb-210)

Manganese (Mn-54)

Mercury (Hg-203)

Neptunium (Np-237)

Nickel (Ni-63)

Plutonium (Pu-238, -239,240)

Polonium (Po-210)

Proactinium (Pa-234)

Promethium (Pm-147)

Radium (Ra-226)

Selenium (Se-75)

Silver (Ag-110m)

Sodium (Na-22)

Strontium (Sr-85-90)

Technetium (Tc-99)

Thallium (Tl-204)

Thorium(Th-230)

Tin (Sn-113)

Uranium(U-232, -234, -235, -236, -238)

Yttrium (Y-88)

Zinc (Zn-65)

D. RADIUM SOURCES HANDLED AND STORED AT ROCKY FLATS

TS*	RFETS ID	Nuclide	Location	Original Activity (μCi)
TS	138	Ra-226	126	6.00000
TS	866	Ra-226	126	10.95
TS	1734	Ra-226	126	0.0182
TS	1779	Ra-226	125	0.9
TS	3938	Ra-226	T441A	0.0315
TS	3939	Ra-226	T441A	0.0135

*TS = Traceable Source

APPENDIX B

EFFLUENT RELEASE POINTS

Calendar Year 2001

Effluent Release Points
Calendar Year 2001[a]

Building/ Location	Number of Release Points	Significant (S) or Insignificant (I)	Notes
Release Points Sampled Throughout 2001			
371-N01	1	S	
371-N02	1	S	
371-SSS	1	S	
374-MAI	1	S	
559-561	1	S	
707-101/103	1	S	
707-102/104	1	S	
707-105	1	S	
707-106	1	S	
707-107	1	S	
707-108	1	S	
771-MAI	1	S	
774-202	1	S	
776-201	1	S	
776-202	1	S[b]	
776-204	1	S	
776-205	1	S	
776-250	1	S[b]	
776-251	1	S[b]	
776-252	1	S[b]	
Release Points Sampled During Part of 2001			
440-101	1	S	No sampling conducted between 3/19/01-4/08/01, 6/25/01-7/09/01, and 11/26/01-12/31/01. Waste repackaging operations were also inactive during these periods (no emissions).
707-R21A/B	2	S[b]	Sampling resumed on 11/05/01 to support decommissioning.
707-R23A/B	2	S[b]	Sampling resumed on 11/05/01 to support decommissioning.
707-R24A/B	2	S[b]	Sampling resumed on 8/06/01 to support decommissioning.
707-R25A/B	2	S[b]	Sampling resumed on 10/01/01 to support decommissioning
Totals	**29**	**25**	

[a] Release points where sampling has been discontinued were listed in the calendar year 2000 report (DOE, 2001).

[b] These emission points were proactively upgraded to "significant" (and monitored accordingly) to support decommissioning work, though the actual material processing and holdup in the areas exhausted through these points may not have the potential to contribute a 0.1 mrem dose in any given year.

APPENDIX C

EFFLUENT INFORMATION SYSTEM (EIS) DATA
2001

Summary Table For The EIS/ODIS Report[a,b]
2001-Release (Ci)

01_ODIS Location	ODIS Location Code	N	Effluent Volume (m^3)	Plutonium 239/240	Americium 241	Uranium 233/234	Uranium 235	Uranium 238
707-101	AFGHB707005	12	8.740E+06	5.410E-11	4.220E-11	2.160E-10	4.000E-11	1.430E-10
707-102	AFGHB707006	12	2.647E+07	7.680E-11	7.360E-11	1.390E-10	7.980E-11	6.830E-10
707-105	AFGHB707003	12	7.504E+07	1.180E-10	-3.470E-11	1.850E-09	-2.690E-10	2.630E-10
707-106	AFGHB707001	12	3.478E+07	5.430E-11	1.560E-10	4.610E-10	2.780E-11	2.770E-10
707-107	AFGHB707004	12	1.914E+08	9.730E-10	9.440E-10	4.510E-09	-7.980E-11	2.520E-09
707-108	AFGHB707002	12	1.074E+08	-2.790E-11	2.020E-10	1.250E-09	3.350E-10	3.090E-10
707-R21[c]	AFGHI707001	2	7.707E+07	6.170E-10	9.220E-10	2.360E-09	-3.210E-10	1.060E-09
707-R23[c]	AFGHI707003	2	7.707E+07	6.830E-12	5.670E-10	1.250E-09	3.450E-10	2.800E-10
707-R24[d]	AFGHI707004	5	1.884E+08	2.650E-10	5.250E-10	3.340E-09	-1.670E-10	1.080E-09
707-R25[e]	AFGHI707005	3	1.199E+08	1.980E-10	1.510E-09	6.480E-11	-1.330E-10	5.790E-10
776-201	AFGHE776003	12	7.440E+06	6.380E-12	4.530E-12	3.270E-10	3.630E-11	3.610E-10
776-202	AFGHE776008	3	7.558E+07	1.200E-10	3.050E-10	-4.600E-10	1.760E-10	6.370E-10
776-204	AFGHE776005	12	1.624E+08	8.360E-10	3.140E-09	3.040E-09	-1.930E-10	4.830E-10
776-205[f]		12	2.340E+08	6.250E-10	2.360E-09	9.530E-10	1.490E-09	4.260E-09
776-250	AFGHE776001	12	1.655E+09	-8.150E-10	4.630E-08	1.040E-07	2.170E-08	7.360E-08
776-251	AFGHE776006	12	3.107E+08	1.970E-09	2.410E-09	-2.060E-09	-5.120E-10	1.460E-09
776-252	AFGHE776007	12	8.850E+07	1.760E-10	6.140E-10	1.800E-10	-1.230E-10	1.360E-10
559-561	AFGHA559001	12	5.820E+08	3.240E-09	-2.840E-10	-5.980E-09	7.750E-10	6.550E-09
771-MAI	AFGHC771001	12	2.594E+09	6.420E-09	1.780E-09	1.680E-08	1.630E-08	1.950E-08
774-202	AFGHD774001	12	9.264E+07	7.790E-11	3.100E-10	1.960E-09	8.930E-11	1.040E-10
374-MAI	AFGHJ374001	12	3.129E+08	5.070E-09	1.310E-09	6.380E-09	9.390E-10	5.720E-09
371-NNN	AFGHC371001	24	4.416E+08	7.130E-09	3.513E-09	9.026E-09	2.317E-09	6.500E-09
371-SSS	AFGHC371002	12	4.487E+08	3.510E-10	1.010E-09	2.700E-09	-3.440E-11	3.950E-10
440-101[g]		12	7.264E+07	3.280E-10	5.740E-10	5.950E-10	1.870E-11	1.710E-09
RFETS		**255**	**7.984E+09**	**2.787E-08**	**6.825E-08**	**1.529E-07**	**4.284E-08**	**1.286E-07**

[a] No longer report Pu-238.

[b] Several locations were removed from this report, as sampling no longer was required or the building no longer exists.

[c] Location(s) reactivated to support building decommissioning 11/05/01.

[d] Location(s) reactivated to support building decommissioning 8/06/01.

[e] Location(s) reactivated to support building decommissioning 10/01/01.

[f] Release points 776-205, -206, and –207 are combined through a mixing plenum and are sampled with one shrouded probe identified as 776-205.

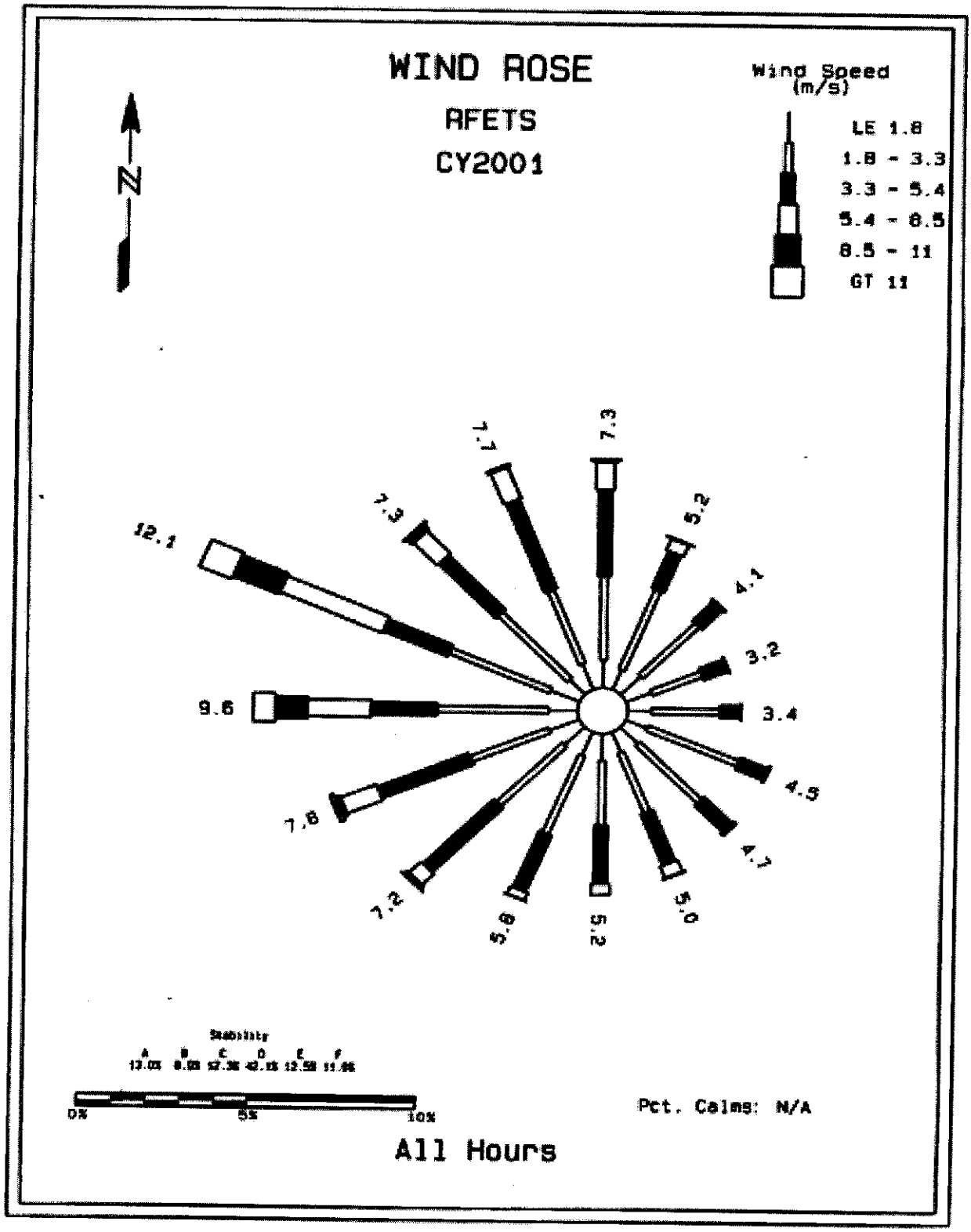
[g] Release point 440-101 was inactive between 3/19/01 - 4/8/01, 6/25/01 - 7/9/01, and 11/26/01 - 12/31/01. No waste repackaging activities occurred during these periods.

Notes:

Ci = Curies
EIS = Effluent Information System
m^3 = Cubic meters
N = Number of samples analyzed
ODIS = Off-Site Discharge Information System
RFETS = Rocky Flats Environmental Technology Site

APPENDIX D

WIND FREQUENCY DISTRIBUTION FOR 2001


WIND ROSE
RFETS
CY2001
N
Wind Speed
(m/s)
LE 1.8
1.8 - 3.3
3.3 - 5.4
5.4 - 8.5
8.5 - 11
GT 11
7.3
5.2
4.1
3.2
3.4
4.3
4.1
5.0
2.5
5.0
7.2
7.6
9.6
12.1
7.2
1.1
Stability
0%
5%
10%
Pct. Calms: N/A
All Hours

APPENDIX E

MODELING SUMMARY

MODELING SUMMARY

Model Description and Use

CAP88-PC is a dispersion and dose model that has historically been used at the Site for calculating EDE to both individual members of the public and to the surrounding population within 80 km. The model simulates the dispersion of airborne radionuclide emissions from point and nonpoint (termed "area") sources to user-specified receptor locations, then calculates an annual, multipathway EDE for a person living or working at each specified receptor location. When combined with population distribution information, CAP88 estimates the collective dose to the surrounding population.

Summary of Model Input Data

The model accounts for dose received from Site emissions through inhalation and ingestion of radionuclides in air and deposited on the ground surface. To simulate pollutant dispersion and calculate dose, the model requires the following types of input data:

- Distance and direction from emission sources to receptor locations.
- Source release characteristics, including stack locations, stack heights, exhaust gas velocities and temperatures, the size of each stack or vent opening for point sources, and the size and location of each area source.
- The amount of each radioactive isotope released from each source.
- Meteorological data including the annual distribution of wind speed, wind direction, and atmospheric stability at the Site, and annual precipitation and temperature information. The model also requires information about the average height of regional temperature inversions (mixing height).
- Agricultural data used in calculating radionuclide ingestion rates including the location, distribution, and utilization of local and regional sources of meat, milk, and vegetables.
- Miscellaneous data regarding the size and solubility of the particles emitted.

To calculate the calendar year 2001 collective dose, Site emissions (sum of all emissions shown in Tables 3-1, 3-2, and 3-3, by isotope) were modeled from a single area source located at the center of the Site. The source was assumed to have an area of 5.3×10^6 square meters (m^2) (about 20% of the total Site area), release height of 0.0 m, and no momentum plume rise (exit velocity of 0.0 meters per second (m/s). These release characteristics were appropriate for the major source of radionuclide emissions in calendar year 2001, which was resuspension of contaminated soil.

Meteorological data for calendar year 2001 were collected from a tower located in the western portion of the Site (the tower location is shown in Figure 4-1). A joint frequency distribution of wind speed, wind direction, and stability was processed for input to CAP88-PC. A "wind rose" graphic representation of the meteorological data is shown in Appendix D.

Annual precipitation and temperature data collected on Site for 2001 show:

- Total precipitation in 2001: 40.64 cm; and
- Annual average temperature: 10.6 °C.

An average mixing height for the Denver, Colorado, area of 1,405 m was used in the model (EPA, 1972).

The CAP88-PC model calculated EDEs over a polar coordinate receptor grid. The grid consisted of 16 compass sectors and 11 distances from the center of the Site: 3 km, 6 km, 10 km, 15 km, 20 km, 25 km, 30 km, 40 km, 50 km, 65 km, and 80 km. CAP88-PC estimates an EDE at the midpoint of each grid cell, then multiplies each EDE by the population within the grid cell to calculate collective dose. Population data for the 2000 census were obtained, organized by census tract, and each whole or partial census tract within 80 km of the Site was assigned to a grid cell. The 2000 census data were scaled up for 2001 using growth estimates by county obtained from the State of Colorado, Department of Local Affairs, Demography Section, and the Denver Regional Council of Governments.

Model default values were used for the median aerodynamic diameter (1.0 micrometers) and solubility class. Urban agricultural data were used in the model. Default values were also used cattle density and for the land fraction cultivated for vegetable crops.

The total collective dose was calculated as the sum of the contributions from Pu-239/240, Am-241, U-233/234, U-235, and U-238.